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ERRATA.

Page 304, line 13, *for* "serious," read "series."

Page 338, line 3 from bottom, for "12,050," read "12,590."

Page 338, line 2 from bottom, for "87,950," read "87,410."

Page 384, line 13, for "acts," read "facts."

Page 394, line 2, for "four," read "three."

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Commonwealth of Massachusetts.

STATE BOARD OF HEALTH, STATE HOUSE, January 27, 1876.

Hon. GEORGE B. LORING, *President of the Senate of Massachusetts.*

SIR:—I have the honor to present to the legislature the Seventh Annual Report of the State Board of Health of Massachusetts, including the special report of the investigations ordered by chapter 192 of the Acts and Resolves passed by the general court of Massachusetts in the year 1875, in regard to the correct methods of drainage and sewerage of the cities and towns of the Commonwealth, especially with reference to the protection of the rivers, estuaries and ponds of the State from pollution.

Very respectfully,

Your obedient servant,

CHARLES F. FOLSOM, M. D.,

Secretary of the State Board of Health.

GENERAL REPORT OF THE BOARD.

To the Honorable the Senate and the House of Representatives of Massachusetts.

The State Board of Health herewith present its Seventh Annual Report:—

The Law Concerning Slaughter-houses and Noxious and Offensive Trades.

No formal petitions have been made to the Board under this law during the past year, except with reference to cases which had already been under consideration; namely, the slaughter-houses in Brighton.

In the case of *Talbot et al.* v. *Corthell, of South Scituate*, judgment had been deferred in 1874. The petitioners are satisfied that the slaughter-house of Mr. Corthell can be managed so as not to be a source of nuisance, and that it has been so managed during the past year. The Board, therefore, voted that no farther proceedings were necessary, and that the petitioners have "leave to withdraw."

In regard to the case of Messrs. John P. Squire & Co., the Board regret that it has not been possible sooner to arrive at a satisfactory decision; but it has been impracticable to do so, owing to the difficulty of eliminating the many sources of possible error in forming judgment.*

The Board have satisfied themselves of the following facts:

I. The last of the basins serving as deposits for filth in the vicinity of the hog-slaughtering establishments in the

* See Sixth Report, pp. 8 to 13.

Miller's River district have been filled, thereby abating one of the most obvious sources of vile odors.

II. All of the three hog-slaughtering establishments—namely, those of John P. Squire & Co., Charles H. North & Co., and the Boynton Packing Company—have been for more than a year past carrying on the various processes of slaughtering and rendering in a satisfactory manner; and, as they are all provided with suitable apparatus for the work, they only need proper care to prevent their becoming sources of nuisance in the future.

III. Six establishments, five of which render house grease more or less decomposed, still conduct their business without proper apparatus to destroy the foul gases.

IV. The complaints, however, have been few in the immediate neighborhood during the past summer.

V. There are still times, generally in the night, and not oftener than once or twice a week, when the characteristic smell of rendering animal matter can be perceived at some distance from the Miller's River district; and it can be traced directly to some of the establishments which are still conducted in an improper manner.

VI. The mouth of the large sewer recently built to carry off the filth of this district has become a source of serious annoyance at low tide, near Craigie's Bridge; so that much of the nuisance has been really transferred from one point to another, although very much lessened in degree.

The Board being of the opinion that the processes, as carried on by Messrs. John P. Squire & Co., are conducted in such manners as to be sources of neither serious annoyance nor of injury to health, have given to the petitioners "leave to withdraw" in the case of *Tyler et al.* v. *Squire et al.*

The satisfactory condition of these large establishments is probably in a measure due to the fact that the reservation of

their opinion by the Board, and their frequent inspections, ha served as an incentive to perfect all the different methods ar machinery, and to keep the standard of care and watchfulne in the management up to the highest point.

Even with perfect appliances, such business cannot properly carried on without the most scrupulous watchfulne and constant attention to all details of the work.

We therefore respectfully recommend that there be so provision made by law for the inspection of such works her after.

The petitioners originally complained of nine establishmen in the Miller's River district as being sources of nuisance; b they have withdrawn from farther prosecution of the case There is nothing more, therefore, that can be done under th law by this Board, unless there be other complaints an another petition sent to them.

THE ABATTOIR AND THE SLAUGHTER-HOUSES IN BRIGHTON

The report of Mr. J. F. Taylor, President of the Butcher Slaughtering and Melting Association, gives the statistics c their operations for the past year. The business has bee conducted in a manner satisfactory to the Board.

Mr. Taylor says: "It gives me much pleasure to be able t report some increase in business at the abattoir for the yea ending December 31, 1875. There have been slaughtered a this place, during the year, 66,541 cattle, 322,705 sheep, an 9,869 calves.

"The business has been done with the usual harmony by al connected with it. I think we may safely say, that no on can be found willing to exchange the convenient and comfort able quarters at the abattoir for the inconvenient, dilapidate places left behind. There is now no slaughtering done in thi ward outside of the abattoir, except occasionally of calves No new buildings of importance have been erected since th last report; those commenced have been finished, and all ar now occupied. We have capacity for dressing all meat needed to supply Boston market and vicinity, but not enoug separate rooms to allow each one the privilege of conducting his business by himself, which is very desirable. The addi-

tion of one double slaughter-house would obviate all the difficulty for some time.

"The offal is taken to the rendering-house every night, and put into tanks, where it is converted into a 'fertilizer' and other products (with some important and satisfactory improvements), as heretofore. All articles produced are considered to be of the best quality, and find a ready market at good prices. The larger part of the tallow is rendered here with good success, and finds a ready market. The tripe business is also now carried on here.

"We feel that we can say, beyond a doubt, that the Brighton abattoir is a success. From a sanitary point of view, also it has proved so, for in not a single instance have I heard a complaint arising from this business."

In May, 1875, the Board received a petition from N. H. Colman and five others, representing that the following-named parties in Brighton—Gunzenheizer Brothers, Charles W. Sanderson, Henry Zoller, William Weitz, George W. Hollis, Walter L. Wilkins, Dennis Kelly and George Bowman—were carrying on the business of slaughtering within the limits of the city of Boston, in the Brighton district, in improperly constructed slaughter-houses, and in a manner "injurious to the health, offensive, and so as to be a nuisance to the public."

By the evidence presented at the hearing, and by repeated personal examinations of the premises, the Board decided that the public health, and the public comfort and convenience, demanded that these slaughter-houses should be closed. Messrs. Sanderson and Hollis agreed to make arrangements to slaughter in the future at the abattoir. The counsel for the complainants withdrew the case of William Weitz. The rest, five in number, were ordered to "cease and desist" on and after July 1, 1875.

Mr. Zoller refused to obey the order of the Board, and an injunction was served upon him by the supreme court, August 6, which he also neglected to heed. He was therefore brought before the said court, August 24, for contempt. He maintained that he had sold out his business to his brother; that his wife, who owned the premises, had leased them to said brother, and that he therefore had not been carrying on the business since July 1.

The court held that Mr. Zoller's action had been s one by which he had hoped to evade the law, although l not intend contempt. He was obliged, consequently, t continue the business.

He and Mr. Wilkins afterwards began business an some of the abandoned slaughter-houses. Mr. Wilkin ordered, thereupon, by the City Board of Health, to ceas desist, when he began again in still a third place. O 27th of October the State and City Boards of Health v together the slaughter-houses of Messrs. Weitz, Zolle Wilkins, which were unanimously agreed to be nuisances as ought to be abated. October 29th the City Boa Health sent to the three above-named parties notificatior on the third day of November following they (the Bo Health) should issue an order of notice forbidding thei tinuance of the slaughtering business in the premise occupied by them. Messrs. Wilkins and Zoller still tr evade the law by using other old and abandoned slau houses, whereupon the following order was passed and lished in the daily papers:—

OFFICE OF THE BOARD OF HEA
BOSTON, Nov. 8, 187

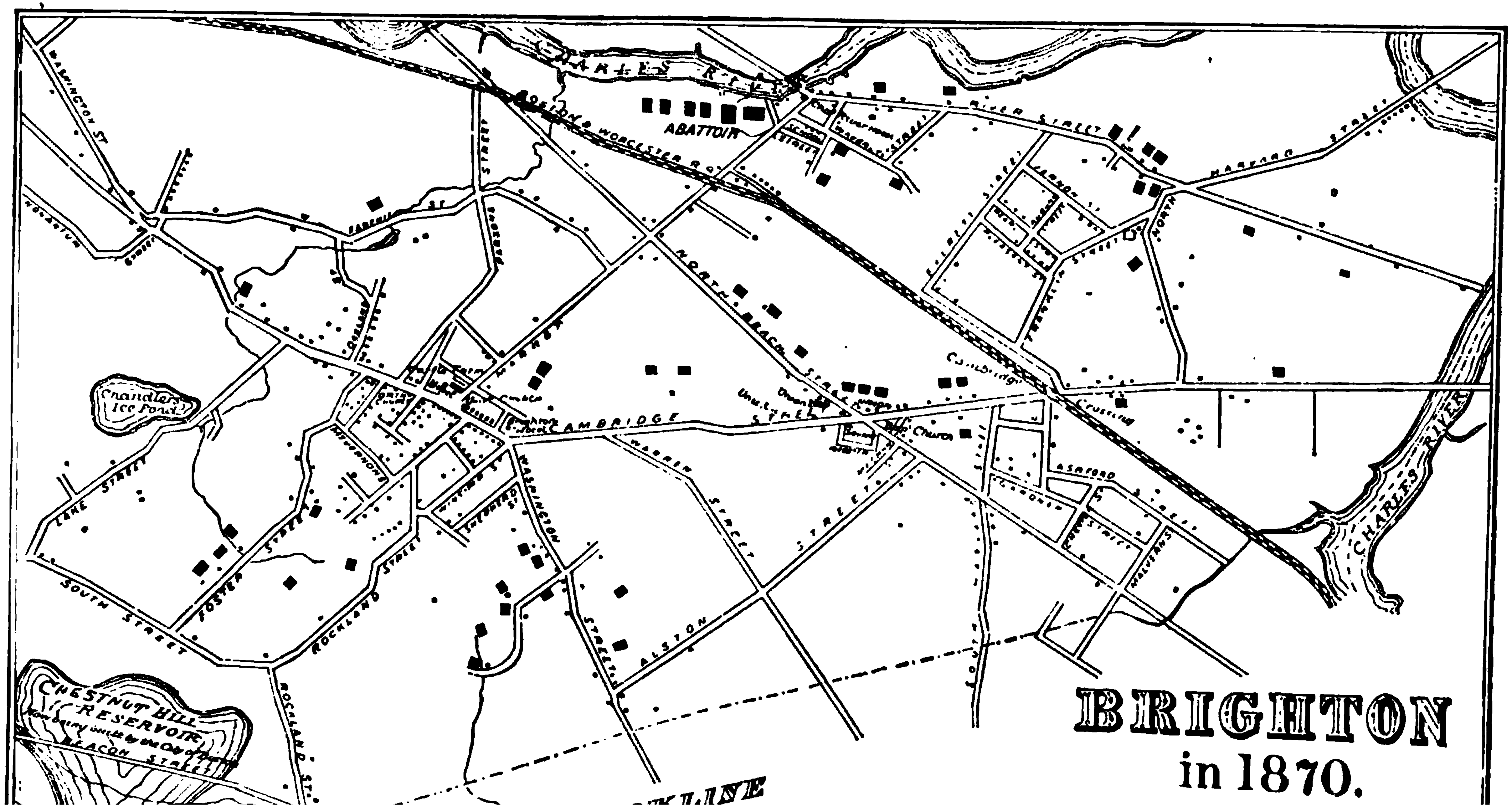
NOTICE TO SLAUGHTERERS AND RENDERERS.

By virtue of the authority given by chapter 26 of the General Statu Board of Health of the city of Boston, makes the following regulatio on and after November 30, 1875, the trade or employment of slaug cattle, calves, sheep or swine, or of rendering tallow or other refuse matter, shall not be carried on within the limits of the city of Boston, on the islands of the harbor, or at the abattoir in the Brighton distri such other place, or places, as may hereafter be assigned by the B Health.

Attest: WILLIAM L. HICKS, *Clerk, pr*

Messrs. Weitz, Zoller and Wilkins appealed to the su court from the above Order. The case has not yet been and, during the pendency of the appeal, the business of sl tering cannot be carried on contrary to the Order. M Weitz and Wilkins are now slaughtering at the abattoi Mr. Zoller in Somerville.

The work of the Board is therefore accomplished, so relief from the great nuisances formerly existing in Bri


BRIGHTON
in 1870.
CHARLES RIVER
ABATTOIR
BOSTON & WORCESTER R.R.
NORTH BEACON STREET
CAMBRIDGE STREET
WASHINGTON STREET
WARREN STREET
ALSTON STREET
HARVARD STREET
RIVER STREET
NORTH HARVARD
FRANKLIN STREET
ROCKLAND STREET
FOSTER STREET
SOUTH STREET
LAKE STREET
WASHINGTON ST
MARKET STREET
ASHFORD STREET
Chandler's Ice Pond
CHESTNUT HILL RESERVOIR
BEACON STREET
Cambridge Crossing

and vicinity is concerned. Since the law under which we acted was originally passed, Brighton has become a part of Boston, and the city has appointed a thoroughly efficient Board of Health, with fuller and more summary power than is possessed by the State Board. They have also, what we have not, the facilities for frequent inspection; and all establishments in Boston, of similar character with the abattoir, are under their charge.

We therefore respectfully request that we be relieved of farther care in this matter, and that the power, at present, possessed by this Board to supervise the construction of buildings and apparatus, and the methods of conducting business in the abattoir at Brighton, be transferred to the City Board of Health. Such a change will conduce to the more efficient execution of the spirit of the law.

In the year 1870 Brighton was dotted with offensive slaughter-houses, as will be seen by the accompanying map. They were described in *the First Report of the State Board of Health*, page 23, in the following language: "The floors of the slaughter-houses are of wood, and are saturated with blood. In most of them there is no sewerage; generally an imperfect drain leads to some marsh or low piece of ground, sometimes to a brook. The surrounding ground is filled with decomposing matter."

In a report on the sanitary condition of Brighton, in 1866, the following words are used: "Any description of the slaughter-houses must fall far short of the perfectly disgusting reality, which can only be appreciated by a personal inspection."

The last three of these great nuisances have recently been closed by order of the City Board of Health. It is a source of great gratification to the Board to be able thus to report, that by means of the efficient aid given by the legislature, and with the coöperation of the City Board of Health, they have been enabled to render a whole town a salubrious and agreeable place of residence; while, at the same time, it has within its limits, though somewhat remote from the residences, an admirably conducted abattoir, which never need be a source of offense, and which is capable of supplying with meat all the inhabitants of the metropolitan district.

The special investigations, made during the year, have l upon the following subjects: —

A SPECIAL REPORT, MADE UNDER THE PROVISIONS OF FOLLOWING ACT.*

AN ACT to provide for an investigation of the Question of the Use of Running Strea Common Sewers in its relation to the Public Health.

Be it enacted, etc.

SECT. 1. The state board of health shall investigate by themselves o agents employed by them, the subject of the correct method of drainage sewerage of the cities and towns of the Commonwealth, especially regard to the pollution of rivers, estuaries and ponds by such drainag sewerage, and to devise and report a system or method by which said or towns may be properly drained, and said rivers, estuaries and ponds be protected against pollution, so far as possible, all with the view to preservation of the health of the inhabitants of this Commonwealth, the securing to the several cities and towns thereof a proper syste drainage and sewerage, without injury to the rights and health of ot also, to report how far said sewage may be utilized and disposed of.

SECT. 2. Said state board of health, or agents employed by them, enter upon and make surveys of lands, so far as may be required, and wit unnecessary injury thereto, and said board may employ such assistants, the consent of the governor, as from time to time may be expedient. shall report to the next general court, not later than the first day of Fe ary, eighteen hundred and seventy-six.

SECT. 3. The compensation of the members of said state board of he or agents employed by them for services under this act, shall be fixed by governor and council, which, with the expenses incurred by them, t approved by the same authority, shall be paid by the treasurer of the C monwealth on the warrant of the governor.

SECT. 4. This act shall take effect upon its passage.

The investigations under this Act have been divided i three heads, with a summary and recommendations by Board.

(*a.*) James P. Kirkwood, C. E., of Brooklyn, appointed by the Board to make a systematic examination certain of the river-basins of the State. He appointed as assistants, E. K. Clark, C. E., L. B. Ward, C. E., and F. Fuller, C. E. He has prepared full maps, which cannot to be of interest and value now and in the future. The m of the water-sheds of the state, too, it is thought, will long used for reference.

* Acts and Resolves passed by the General Court of Massachusetts in year 1875, Chap. 192.

Mr. Kirkwood has brought to the work a rare experience and a thorough knowledge of sanitary engineering. His conclusions and suggestions are fully concurred in by the Board.

In the five basins,—namely, the Blackstone, the Charles, the Neponset, the Chicopee and the Taunton,—only one place is found where legislative action is demanded at present. The Blackstone River is seriously polluted, and some remedy is called for. To meet the requirements of this case, Mr. Kirkwood considers the method of irrigation the most feasible, at least so far as the summer months are concerned. He advises, however, very wisely, that the details of the method be determined by experience. "Beginning with what can be done, the difficulties which these exceptions present will gradually solve themselves, and it would be needless now to speculate upon the precise way in which this will be accomplished."

With regard to systems of sewerage, Mr. Kirkwood says: "To devise a system which, within the compass of a report of this kind, would be applicable in all its details to all cities and towns, would be impossible; every city or town must be the subject of a separate study by a competent engineer, founded on a correct and minute survey of the streets or ground to be drained or sewered, with correct levelling of the whole." The writer, however, gives a few of the important principles to be followed, stating that sewage should always leave a city within twelve hours, at most, after its generation, and that it should never be retained long enough to become putrid.

Mr. Kirkwood's report is followed by an appendix by Prof. W. Ripley Nichols, on the examination of river-water, and the significance of the facts revealed by chemical analysis. He gives five series of tables, embracing a very large number of determinations of the waters of the five valleys which were examined during the past summer. These analyses, made with great care and accuracy, show that the condition of the five rivers is not yet very bad, and that an immediate remedy is called for only in the Blackstone below Worcester.

(*b.*) Dr. F. Winsor, of Winchester, has examined the question in its sanitary bearings, with the view of ascertaining the actual amount of evil now existing in the State arising from our present method of disposing of our filth. It will be

seen from his report that forty-eight cities and towns have introduced water-supplies for a greater or smaller proportion of their population, while less than half of these same places have any sewers whatever, even the most imperfect. Comparatively little sewage, therefore, gets into our streams.

The greatest evil at present, as shown by him, is undoubtedly the damp and polluted condition of the soil, arising from want of drainage and sewerage. From this cause come too often vitiated water and contaminated air. In small towns and villages, and in isolated houses, slop-water is a fruitful source of mischief and annoyance. When thrown upon the ground day after day, where there is little or no vegetation to purify it, conditions are produced favorable to the development of disease. Neglected privies only add to the danger.

In such cases, the best methods are too costly for general adoption. The writer shows the importance of absolute cleanliness in all these matters, and points out the most practicable methods of attaining it.

The necessity of legislative action is clearly indicated in regard to some of the cities and towns, which will be mentioned in detail in the summary by the Board.

(*c.*) The Board requested their Secretary to visit Europe, in order personally to examine the methods pursued by various cities in regard to their disposal of sewage. He has given a brief statement of the history of the disposal of filth in European countries, and the steps by which they have arrived at their present positions with regard to the matter.

It will be seen that the water-carriage system is gaining in favor throughout the civilized world; that with care, it is the most convenient and the least objectionable method, and of the greatest advantage in a sanitary point of view, although there are evils peculiar to it which should be carefully provided for.

Where it is possible to do so, the cheapest, and, on the whole, a satisfactory way of disposing of sewage, is to discharge it where it will be carried off without returning, and be diluted in a large volume of water. If this is not practicable, irrigation with the sewage in a fresh state is the most satisfactory solution of the question, at least so far as we may judge from experience in England, France and Germany. Sewage farms

are not prejudicial to health, if properly managed, and a serious pecuniary loss probably need not be incurred from them. When experience has pointed out the best method of carrying them on, it is fair to expect that the process may be attended with profit.

(*d.*) The summary by the Board contains suggestions as to the best practical methods known to them of meeting the question as it now stands. Their conclusions and recommendations are signed, also, by Mr. Kirkwood, Dr. Winsor and Prof. Nichols.

Cities and towns are mentioned where some action is called for. The Board, however, do not advise any general coercive legislation to cover the whole ground at present.

That the sewage of Boston,* Worcester, Cambridge, Somerville, Salem, Lynn, Woburn and Natick should be dealt with in a manner different from the present, is evident. In other and smaller places, there are also difficulties to be met.

The laws, as now on the statute-book, do not really provide effectual relief for such cases.

In Worcester and Woburn, irrigation would probably be practicable. In the other cities mentioned, different remedies must be applied. Intercepting sewers would meet the requirements of most cases.

In the discharge of the sewage of Natick into Pegan Brook, and finally into Lake Cochituate, there is an ever-threatening danger to the inhabitants of the only large city in our State.

The principle may be broadly stated that *where filth is made, there it should be disposed of.* Every city and every town should be required by law to prevent their filth from annoying their neighbors, or endangering their health.

In order to carry out proper systems of water-supply, sewerage and drainage, each river-basin should be considered as a whole and by itself. In England, different towns lying in one river-basin sometimes unite to form a common system of

* The sewerage of Boston has already been made the subject of a special examination and report, which includes a plan of intercepting sewers capable of disposing of the sewage of the entire metropolitan district, by discharging the same on the ebb-tide at such points that it will be carried out to deep water. See Dr. Winsor's Report, which follows; also City Document No. 3, Boston, 1876.

sewerage, and share the expense of disposing of their filth. Great benefit has arisen in that country, too, from the large powers given to the Local Government Board and to sanitary authorities under recent acts. The appointment of a consulting engineer of eminence, too, has been of the greatest value to cities and towns desiring to get authoritative approval of plans for water-supplies and sewerage.

It is the opinion of the Board that the water-courses in this State can be saved from serious pollution best by placing in some central authority advisory power, upon whose recommendations legislative action should be based to meet each particular case.

In this connection, we would respectfully suggest for the consideration of the legislature the appointment as state engineer of some gentleman of skill and experience, to be paid by the parties who consult him.

There should be absolute prohibition in all cases against casting sewage or filth of any kind into any stream or pond used as a source of water-supply. Where such conditions now exist, the sewage or filth should be diverted to some other channel. For, until our knowledge has so far advanced as to enable us to recognize "germs" of disease, and to destroy them effectually by some simple and easy process, even purified sewage must always be looked upon as a dangerous addition to drinking-water.

The following are the recommendations which the Board respectfully offer in their summary :—

1. That no city or town shall be allowed to discharge sewage into any water-course or pond without first purifying it according to the best process at present known, and which consists in irrigation; provided that this regulation do not apply to the discharge from sewers already built, unless water-supplies be thereby polluted; and provided also that such intended discharge can be shown to be at such point or points that no nuisance will arise from it.

2. That no sewage of any kind, whether purified or not, be allowed to enter any pond or stream used for domestic purposes.

3. That each water-basin should be regarded by itself in the preparation of all plans of sewerage and water-supply.

4. That accurate topographical surveys be always made of all towns before introducing water-supplies or sewers.

5. That steps should be taken, by special legislation based upon investigations and recommendations of experts, to meet cases of serious annoyance arising from defective arrangements for the disposal of sewage.

6. That irrigation be adopted, at first experimentally, in those places where some process of purification of sewage is necessary; and that cities and towns be authorized by law to take such lands as may be necessary for that purpose.

7. That every town or city of over four thousand inhabitants be required by law to appoint a board of health, the members of which shall not be allowed to hold any other offices in the government of their city or town.

Finally, the Board feel that, in the present state of our knowledge, sweeping laws for the general and immediate purification of all our streams would be hardly justifiable, and that they are not called for by the present condition of our rivers.

They hope to continue their investigations during the present year, for which no special appropriation will be required.

Sanitary Hints.

By Henry I. Bowditch, M. D., Chairman of the Board.

The writer contributes several interesting lessons from his own experience, with the remark which the Board desire to emphasize "that it is expedient to keep practical questions of sanitary law and work constantly before the people." The importance, and even the necessity, of better attention to hygienic requirements, if we would have health, are brought forward in this paper, and we hope that the suggestions offered will receive careful consideration from the community.

Defects in House Drainage, and Their Remedies.

By Edward S. Philbrick, C. E., of Brookline.

The large experience of the writer in the construction and arrangement of dwellings has enabled him to give practical results in regard to matters which are too much neglected in many of our houses. It is an interesting fact that the investigations carried on during the past year by so many observ-

ers, acting independently of each other, have led them to the same conclusion; namely, that for our climate and our people, at least, there is absolutely nothing which can take the place of well-ordered water-closets. The writer places before us many instances of almost criminal carelessness in the construction of houses, and shows the importance of licensing plumbers and builders, and the necessity of having their work inspected by some competent officer before it shall be covered up or allowed to be used.

Report of an Outbreak of Intestinal Disorder Attributable to the Contamination of Drinking-water by Impure Ice.

By Arthur H. Nichols, M. D., of Boston.

The careful analysis by which all other sources of disease are excluded in this case, and the rarity, if not the unique character, of the outbreak, render this paper a valuable contribution to sanitary literature. Impure ice has already been suspected of at least serving to aggravate disease; it is thought that this is the first direct proof that serious illness has been caused by it.

The Registration of Prevalent Diseases.

By Frank W. Draper, M. D., of Boston.

This paper embodies a summary of weekly tabulations of prevalent diseases, reports of which were collected throughout the year by the writer under the authority of the Board. The experiment has been carried out ably and faithfully, and has been of great interest and value. It has not been possible to reach statistical accuracy, nor is that to be expected until physicians generally can be induced to record faithfully and truly all their cases, sending their reports to some central office for condensation.

The results which have been obtained by the writer lead us to hope that a complete system of registration may finally grow out of his work. During the past year, weekly reports have been received from nearly one-third of the cities and towns in the State. The knowledge of the appearance of epidemics which even this imperfect registration has given us has been very interesting and suggestive. It is hoped that a

larger corps of observers may be enlisted in the work, and that the Board will be able to carry on and extend a system from which admirable results may be expected. To do this thoroughly, we shall need an enlarged annual appropriation; but the importance to the community of having the knowledge which would be got in this way, will fully repay the small sum which will be required. Registration of disease to supplement the incomplete information got from death-rates, is deemed of vast importance in all countries, and this paper is the first practical contribution to the subject.

We desire to express our cordial thanks to the physicians throughout the State, to whose hearty coöperation in the work we are so much indebted.

The Mortality of Boston in 1875.

By Edward H. Bradford, M. D., of Boston.

Dr. Bradford has used the same divisions in the city which were made by the late Dr. Derby, five years ago. The statistics this year are not so complete in the regard to the mortality among children as those given in 1870. The density of the population, an important element in the causation of disease, is given by the writer; and he has carefully pointed out those parts of our city in which the mortality has been excessive. Some suggestions are given, too, as to probable causes, of which bad drainage is one of the most potent.

In many cases, the results obtained this year are the same as were shown by Dr. Draper's tables in 1870. The low, incompletely drained parts of the city will be seen to have the highest mortality, other things being equal, from the preventable diseases.

It is very desirable that similar investigations should be carried out by local boards throughout the State, inasmuch as they furnish the most valuable bases for locating and determining the causes of disease.

The Surface Drainage of the Metropolitan District.

By Charles W. Folsom, C. E., of Cambridge.

The writer has given a brief sketch of the most important of the low-lying districts in and near Boston, which are also

shown in some detail in the accompanying map. Probably one of the most powerful factors influencing the health of the community throughout the State, extreme poverty excepted, is the condition of the soil upon which their houses stand. The subject is a suggestive one, and merits thoughtful consideration.

HEALTH OF TOWNS.

We desire to express our thanks to our correspondents in different parts of the State for the very full and valuable information which they have sent to us with regard to the prevalence of disease during the past year.

In the majority of the cities and towns, there are no permanent boards of health, the selectmen or a committee of the local government usually serving as such. Many of our correspondents point out the evil of this condition of things in incomplete and inaccurate registration of causes of death, in insufficient attention to measures tending to the prevention of disease, and in general neglect of the vital questions of sewerage and drainage. They have attributed a large amount of preventable disease to causes which admit of being readily removed, and especially to want of attention to the speedy and complete removal of filth.

Many facts and suggestions are given as to the predisposing causes of diphtheria, its prevalence, etc. In our State, at least, this disease, as well as typhoid fever, is very often found associated with bad drainage, and has thus far been of greatest severity in rural districts where there are no sewers and no proper draining of the soil.

We thank the registrars of the cities for their politeness in furnishing the statistics which have enabled us to prepare our weekly reports of mortality.

During the months of July, August and September, Dr. W. L. Richardson filled the office of Secretary *pro tempore*. Upon his retirement, the following vote was unanimously passed:—

Resolved, That the thanks of the Board be presented to Dr. W. L. Richardson for his faithful, able and efficient discharge of the duties of the office of Secretary *pro tempore* during the absence of the Secretary.

At the last session of the legislature, the sum of $500 was appropriated for the purchase of books, maps, journals, etc., for the library of the Board. It has been our aim to procure only such material as cannot readily be found in other libraries, and it has not been necessary to use any of the money appropriated for this special purpose.

As the metric system of measures is used in parts of the Report, and is likely to come into general use at no very distant day, a table of equivalent values is given.

All of which is respectfully submitted.

HENRY I. BOWDITCH.
RICHARD FROTHINGHAM.
JOHN C. HOADLEY.
DAVID L. WEBSTER.
THOMAS B. NEWHALL.
ROBERT T. DAVIS.
CHARLES F. FOLSOM.

THE METRIC SYSTEM.*

Weight.

1 kilogram	=	1,000	grams.	[2.6795 pounds Troy.]
1 hectogram	=	100	grams.	[3.2154 ounces.]
1 decagram	=	10	grams.	[0.3215 ounce.]
1 gram	=	1	gram.	[15.4339 grains.]
1 decigram	=	0.1	gram.	
1 centigram	=	0.01	gram.	
1 milligram	=	0.001	gram.	

1 kilogram is equal to a weight represented by one liter of water, at 4° C.†

Length.

1 kilometer	=	1,000	meters.	[0.6214 mile.]
1 hectometer	=	100	meters.	[19.8830 rods.]
1 decameter	=	10	meters.	[32.8070 feet.]
1 meter	=	1	meter.	[3.2807 feet.]
1 decimeter	=	0.1	meter.	[3.9368 inches.]
1 centimeter	=	0.01	meter.	
1 millimeter	=	0.001	meter.	

Capacity.

1 cubic meter	=	1,000	liters.	[35.3104 cubic feet.]
1 cubic decimeter	=	1	liter.	[61.016 cubic inche
1 cubic centimeter	=	0.001	liter.	[0.06102 cubic inch.

1 liter = 1.761 imperial pints = 2.113 pints, wine measure.

The stère, the unit of solid measure, contains one hectoli gals., or 1.308 cubic yards].

The are, the unit of surface, contains a hundred square me square yards].

1 inch	=	2.5	centimeters (nearly).
1 foot	=	3.048	decimeters.
1 quart, wine measure,	=	0.946	liter.
1 pound Troy	=	0.373	kilogram.
1 ounce Troy	=	31.104	grams.
1 acre	=	0.4046	hectare.

* Many of the names in the French system (like our "dime") practical use; *e. g.*, hectometer, decagram, etc.

† In the centigrade scale 0 (32° + F.) is the freezing-point; 1(+ F.) is the boiling-point. Five degrees C. correspond to nine d

EXPENSES OF THE BOARD.

REGULAR APPROPRIATION.

Books,	$390 04
Binding,	81 45
Maps,	36 00
Photographs of Hospitals,	9 50
Office Furniture,	40 50
Messenger,	31 95
Carriage-hire,	103 50
Travelling Expenses,	109 81
Clerical Services (T. H. Hay),	153 00
" " on Consumption in Massachusetts,	461 72
" " Indexing Report,	22 00
" " on Infant Mortality,	136 70
Postage and Stationery,	1,074 47
Printing and Stationery,	294 37
Drawings of Maps, Plans, etc.	40 50
Pole-axe and Schlacht-Maske for Abattoir,	27 45
Express,	129 86
Telegrams,	4 94
E. Dewson, drawing Plans of Abattoir,	75 00
A. C. Martin, " " " (1873),	125 00
Lucien Prince, Services on Sixth Report,	133 99
Professor W. R. Nichols, Chemical Analyses,	129 40
F. W. Draper, Registration of Diseases and Report,	266 03
For Special Investigations and Reports (E. H. Bradford, E. G. Cutler, C. W. Folsom, G. T. Hough, E. R. Howe, A. H. Johnson, F. Nickerson, A. H. Nichols, F. E. Oliver, E. S. Philbrick, W. L. Richardson),	1,020 00
Miscellaneous,	4 40
	$4,901 58
Deduct for sale of shelves,	16 69
	$4,884 89

Special Appropriation.

Investigations and Report (including travelling expenses), Jas. P. Kirkwood and Assistants,	
W. Ripley Nichols, Chemical Analyses,	
Expenses of Secretary in Europe,	
W. L. Richardson, Secretary *pro tem.*,	
C. W. Folsom, Surveys and Report,	
F. Winsor, Report and Expenses,	
W. R. Nichols, Analyses of Water,	
Express,	
Drawings of Maps and Plans,	
Travelling Expenses of the Secretary,	
Clerical Services,	

A SPECIAL REPORT

ON

I. THE POLLUTION OF RIVERS; AN EXAMINATION OF THE WATER-BASINS OF THE BLACKSTONE, CHARLES, TAUNTON, NEPONSET, AND CHICOPEE RIVERS; WITH GENERAL OBSERVATIONS ON WATER-SUPPLIES AND SEWERAGE. By JAMES P. KIRKWOOD, C. E., of Brooklyn, N. Y.

WITH AN APPENDIX, GIVING

CHEMICAL ANALYSES. By W. RIPLEY NICHOLS, Professor of General Chemistry in the Massachusetts Institute of Technology, Boston.

II. THE WATER-SUPPLY, DRAINAGE AND SEWERAGE OF THE STATE, FROM THE SANITARY POINT OF VIEW. By FREDERICK WINSOR, M. D., of Winchester.

III. THE DISPOSAL OF SEWAGE. By CHARLES F. FOLSOM, M. D., Secretary of the Board.

IV. SUMMARY AND RECOMMENDATIONS.

RIVERS POLLUTION.

To the State Board of Health of Massachusetts.

GENTLEMEN:—The undersigned has the honor to submit the following statement, growing out of the duties which were assigned to him, on the question of the pollution of the rivers of the State.

JAMES P. KIRKWOOD,
Civil Engineer.

BROOKLYN, 14th December, 1875.

PART I. — PRELIMINARY.

The law requiring the special information, and, incidentally, the examinations to be noticed in this Report, reads as follows:—

AN ACT to provide for an investigation of the question of the use of Running Streams as Common Sewers in its relation to the Public Health.

Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the same, as follows:—

SECT. 1. The State Board of Health shall investigate, by themselves or by agents employed by them, the subject of the correct method of drainage and sewerage of the cities and towns of the Commonwealth, especially with regard to the pollution of rivers, estuaries and ponds by such drainage or sewerage; and to devise and report a system or method by which said cities or towns may be properly drained, and said rivers, estuaries and ponds may be protected against pollution, so far as possible, with the view of the preservation of the health of the inhabitants of this Commonwealth, and the securing to the several cities and towns thereof a proper system of drainage and sewerage without injury to the rights and health of others; also, to report how far said sewage may be utilized and disposed of.

SECT. 2. Said State Board of Health, or agents employed by them, may enter upon and make surveys of lands, so far as may be required, and without unnecessary injury thereto, and said Board may employ such assistants, with the consent of the governor, as from time to time may be expedient. They shall report to the next general court, not later than the first day of February, eighteen hundred and seventy-six.

SECT. 3. The compensation of the members of said State Board of Health, or agents employed by them, for services under this Act, shall be fixed by the governor and council, which, with the expenses incurred by them, to be approved by the same authority, shall be paid by the treasurer of the Commonwealth, on the warrant of the governor.

SECT. 4. This act shall take effect upon its passage.

The above Order has in view two important means towards the security and improvement of the general health, one of which, sewerage or drainage, has long been pretty well understood, and to some extent acted upon; and the other, the maintenance of the purity of our running streams, has been in the United States as generally neglected.

Throwing together the sentences of the law which refers to sewerage, it requires the Board of Health "to investigate the subject of the correct method of drainage and sewerage of the cities and towns of the Commonwealth," and to devise and report "how far said sewage may be utilized and disposed of."

In regard to the rivers of the Commonwealth, it requires the above investigation to be made "especially with regard to the pollution of rivers, estuaries and ponds by such drainage or sewerage," and to devise a system by which "said rivers, estuaries and ponds may be protected against pollution, so far as possible, all with the view of the preservation of the health of the inhabitants of this Commonwealth, and the securing to the several cities and towns thereof a proper system of drainage and sewerage, without injury to the rights and health of others."

In previous reports of this Board, particularly the fourth and fifth annual reports, the general questions of sewerage of towns and pollution of rivers have been very thoroughly discussed. In reviewing the same questions now, some repetition will be unavoidable; but, remembering what has been

already said, and that the literature of the subject is now large and accessible, we will endeavor to condense what may require to be said again to meet the Act already quoted, and to further the objects which it has in view.

Without attempting to keep the subjects above defined separate, where they may naturally come together, the present condition of our rivers will first be looked at,—how far they are polluted now, and the evils which that pollution entails, whether under ordinary or exceptional circumstances. To this end, as examples of the polluting exposure to which the rivers of the State are subject now, an exposure against which there is practically no defence through the common law, five of the river-valleys of the State have been examined, and an account taken in each case of all the points where sewage or pollutions of any kind enter the river, including necessarily all factories, the refuse fluids of which enter, and to that extent degrade, the waters of the several valleys. The fluid waters flowing from factories of all kinds will be seen to be the chief cause of pollution in the valleys examined, except the Blackstone; the animal sewage, being as yet but rarely concentrated, is not so palpable, but it is greater, probably, in the aggregate than can be made to appear in the statistics.

The sketches of the valleys attached to this Report will show to the eye their extent and general character, with the positions of the objectionable elements referred to. The statistics will be summarized presently; but, although the mere statement of some of them will sufficiently offend the cleanly instincts of most persons, there are others who will reasonably want to know whether the delivery of a certain amount of such polluting fluids or matters into a river-course necessarily renders that water unfit for domestic use, and injurious to health. The facts affecting this view of the case, to whichever side they lean, should be fairly presented.

It may suffice to refer to the Thames and the Lea, at London, as exhibiting both the apparent insensibility of the human stomach to waters exposed to a considerable measure of impurities, as well as its fearful sensitiveness under the use of the same waters (polluted, some would say, but lightly by sewage) during the prevalence of an epidemic.

It cannot be said that all rivers receiving sewage in degree are unfit for use; for, of the rivers from which w is freely drawn for human use, there are very few that not exposed to pollutions of one kind and another, even to their sources. There is no such thing as pure water, at the sources, nor anywhere except in a laboratory.] water, therefore, or good water, in ordinary parlance understood by the engineer to mean a palatable, wholes water, not insipid like rain-water, and not open to the re tion of that class of impurities which endanger the indivi health. Palatable water will always have some foreign ir dient in it, which is not necessarily unwholesome; when lution, therefore, is spoken of in connection with rive refers to those kinds of impurities which, when known, sh make the water repulsive for human use. That it doe always do so is the effect of custom, which gets men ha ated to almost any evil which is ever present, especially it cannot by an effort of will be promptly remedied. Ir case, too, the evil is but rarely present to the senses at point where the water is used; it is only known by con report.

The Second English Rivers Pollution Commission giv following as "the chief characteristics of unpolluted w It is tasteless and inodorous, possesses a neutral or fa alkaline reaction, rarely contains in 100,000 pounds than one-half pound of carbon and one-tenth poun nitrogen in the form of organic matter, and is incapal putrefaction, even when kept for some time in close ve at a summer temperature."

In our own country, we have the water-supply of Phi phia to point to, taken from the Delaware and the Schu both at places where the water has been much exposed to lution; and we have the water-supply of Cincinnati, from the Ohio River at a point very near to the larges worst sewer of the city. In Philadelphia, at least effective pollution is probably greater than on the Th because the water is taken from the streams at points r to the polluting deliveries than on the Thames; though deliveries may be much less in volume when compared the general volumes of the streams which receive them.

On the Schuylkill, the aggregate of polluting fluids entering the river above Philadelphia is represented to be greater than on the Thames above London, comparing equal volumes of their waters.

We are presented with the same anomaly here that occurs when we compare the annual death-rate of London under the exposed waters of the Thames and Lea with the death-rates of other cities that are supplied with water purer in every way.

The latest statistics within our reach give the annual rate of mortality for New York as twenty-nine per thousand of the population, taking the average of the four years 1870, '71, '72, '73. The average of the same four years for Philadelphia gives twenty-three per thousand. But the Croton waters which supply New York are not exposed, except in a very small way, to any of the impurities which so markedly mix with the waters of the Schuylkill and the Delaware.

The populations of these two cities are somewhat different in general character. New York includes more of a foreign and a floating population, and is in some of the wards very densely occupied. A large part of its working population leave the city at night, however, and find cheap homes in New Jersey and Long Island, whereas the working population of Philadelphia remain within the city lines.*

The reports of the Board of Health of New York give the following as the annual death-rates per thousand, for 1871 and

* By the census of 1870, we have the following statistics:—

CITIES.	Total Population.	Per cent. of Foreign Populat'n.	Total area of city in square miles.	Average Population to each square mile.	No. of dwellings.	No. of persons to each dwelling.
New York, ...	942,292	.44	40.6	23,209	64,944	14.72
Philadelphia, . . .	674,024	.27	122.0	5,525	112,266	6.01

The average density of population is considerably less in New York than in London, which has an area of 117 square miles, and had by the last census (1871) a population of 27,793 to the square mile. The average density of population in Liverpool is even twice as great as it is in London. Philadelphia has lately annexed a large area of country which is very sparsely settled.

1872 in the British cities named. I am not able yet to the returns for 1873 and 1874:—

	1871.	1872.		1871.
Liverpool, . . .	35.1	27.1	Edinburgh, . . .	26.9
Leicester, . . .	26.8	26.8	Glasgow, . . .	32.9
Manchester, . .	28.6	31.2	Dublin, . . .	26.2

All of these English cities derive their water from gro which are free from the polluting influences to which River Thames is exposed, and yet the death-rate of Lo is somewhat below that of any of these cities, being 24.7 1871, and 21.4 for 1872. This kind of comparison is ne sarily imperfect, because in the manufacturing cities population is more concentrated than in London, and amount of deprivation and exposure leading to sickness suffering probably much greater. The sewerage, too most of these places is still imperfect as compared with l don. Still, under ordinary circumstances, it would seem be plain that a considerable measure of impurity may into river-waters without sensibly affecting the health of communities living on them and using them, under ordi circumstances, provided that the water is drawn from p five to ten miles distant from where the poison enters stream. The London water companies take their wa from the river at Hampton and Kingston; the sewage Windsor and Eton enter the river some fifteen miles or r above these points; and, although the banks of the str particularly in the eddies, are said to show marks of impurities which it has received above, its presence at Ha ton, where the water is taken for the city, cannot be sens distinguished, or proven to have communicated to the w any dangerous qualities, under ordinary circumstances. this condition of things (as now understood), we are debted to the fact of the volume of sewage being very s compared with the volume of water in the river; the sev must be so largely diluted as to have become almost an i preciable quantity. To secure this dilution, it is obv that, if the river be a quiet, slow-flowing stream, it m take ten to twenty miles to produce the required mixing

if fast-running, or pouring over dams and falls of water, a much less distance would have the same effect. If we dilute urine with a sufficient quantity of clean water and mix it thoroughly, no chemist could detect the impurity; nor could it be shown to be dangerous in any sense, however disgusting the knowledge would be that it was there.

A larger measure than this, including trade impurities, probably exists in the Thames water now at the points where it is used; for at this date (1875) we are informed that Oxford, Reading, Abingdon and Windsor still pass their sewage into the river, although they have commenced sewage works which will in time more or less remedy the evil.

It was long thought that sewage was destroyed by running water, but now it is believed by chemists to be all but indestructible there, and to be rendered insensible, as already said, and inert, only by being mixed largely,—thoroughly diluted, in other words, with at least one hundred times its volume of good water. Sewage distributed over land is appropriated like manure by the vegetation which it finds there, but, passed into running water, it finds little or nothing there requiring its aid. In the one case, it is where it is needed; in the other case, where no profitable use can be made of it. In the still, clear water of shallow ponds, vegetation will often be profuse, protecting the water by such large floating leaves as those of the pond-lily from the hot rays of the summer sun; and in the clear pools of sluggish but pure streams, the vegetation along the banks will often be considerable; but in running water there is but little vegetation,—none, it may be said, if the water is turbid or foul. In running water, therefore, such as mostly prevails in the rivers of the State, the sewage flows on with but little absorption from the very few plants it meets.

It is not to be forgotten that the Thames water is very sensibly improved by the process of filtration to which it is subjected before being delivered to the city. This filtration does not merely remove the sediment which may be in suspension, but it removes a large portion of the organic matter (forty-seven per cent., Dr. Frankland says) which finds place in the natural waters of the river. In the comparison made above with other cities, it is to be noted that the waters of

Manchester and Glasgow are not filtered; the waters, h ever, of Leicester, Liverpool and Dublin are filtered, a portion of the Edinburgh supply.

In large cities, any measure of uncleanness and impu will be submitted to by the poor and the helpless; and those who are better off are roused in their own interest, for their own protection, to remedy this tendency, the taints engendered by the indifference to cleanliness v accompanies extreme poverty, as well as the inaction v belongs to it, will contaminate and render supine the and, as in many European cities, both classes will have their noses, it might almost be said, a condition of thing could never long be tolerated here.

If we look again to the Thames, the lessons from whi very marked, we are reminded that the very impure delivered to the city before 1849 was borne with unt cholera appeared, and the fearful exaggeration of its r within the city was traced prominently, if it cannot l entirely, to the character of the water used. How muc chief is done by the measure of sewage-impurities w drunk now with the waters of the London supply a Philadelphia and Cincinnati supplies, cannot be kno slow and insidious may be its effects on the constitutio no epidemic is present to bring the poison into dayligl

To understand fully the risk which follows the con tion by sewage, especially of potable waters, it will b sary to review the cholera epidemics of 1849 and London.

We are not able to make the kind of comparis would enable us to understand the benefit to the hea city population consequent on the use of entirely un water, as contrasted with the effect produced by th polluted water on the health of another population situated. Such cases, in all respects similar, do n but, from the water-history of London, the effect different measures or degrees of polluted water can c traced. The cholera epidemics of 1849, 1854 and 1 very distinct lessons in this respect, and their his far as they are connected with the water-supply, w fore be briefly traced.

The metropolis of London is supplied with water by eight companies, five of which take their water from the Thames, two from the river Lea, a tributary of the Thames, and one (the Kent) from artesian wells in the chalk.

During the cholera epidemic of 1848–9, all the companies delivered their water to the city without filtration, the Thames companies taking from the Thames on tide-water, which was at that time subject to the entire sewage-impurities of the city, as well as of all places above it on the banks of the Thames, or of the Lea, which found it convenient to pour their sewage into these rivers or their branches. The epidemic of 1848–9 left the conviction—without, it may be said, absolute proof—that its severity was more or less due to the impurity of the water-supply, and a law was passed, in consequence, requiring all the Thames water companies to take their supplies from a point above tide-water and above London, and to have the water sufficiently filtered before delivering it to the city. A certain period of time was given the companies to make this change and to construct the proper filtering works. The cholera visitation of 1853–4 found certain portions of the city supplied with filtered water taken from the Thames above the city and above the influence of the tidal flow, and certain portions still supplied as before; some of the water-companies having managed in the interim to change their point of in-take to a position up the river, beyond the influence of the sewage of the city, having made provision at the same time for the settling and filtering of the water; while others of the companies had not yet effected the required change of location, nor completed the necessary filtering works.

This cholera epidemic of 1853–4 showed very distinctly that in those parts of London where the filtered water taken from above the influence of the sewage of the city was used, the epidemic was very much less malignant than where the more impure water was used, taken from within the influence of the sewage of this great city. The General Board of Health took some pains to gather the statistics illustrative of this fact. Mr. J. Simon, F. R. S., in his report to the board, made in May, 1856, selects the two water companies for comparison which were supplying the same class of

houses, and as near as may be the same kind of popula
the pipes of the two companies for a portion of their dis
being laid in the same streets, each supplying about the
proportions of the houses in these streets. The one
Lambeth, was delivering, in 1853–4, good water, spe
comparatively, from the Thames at Ditton; the other
Southwark & Vauxhall, delivering bad water from the Tl
at Battersea, as in 1848.

"Commonly, in attempting such inferences, the inqui
baffled by difficulties which render exact conclusions ii
sible; for populations drinking different waters will oft
living in different circumstances of wealth, comfort, oc
tion, cleanliness, soil, climate."

"In reference to the comparison which had to be ma
is especially important to observe that the tenantries of
two great companies were not set on different parts
South London area, each isolated from the other. O
contrary, the two populations were, so to speak, mu
interfused. Of thirty-one sub-districts into which the
space is divided, only eight were monopolized by a
water company; while of the remaining twenty-three,
was supplied sometimes in equal proportion by one co
and the other."

"In the 24,854 houses supplied by the Lambeth Con
comprising a population of about 166,906 persons,
occurred 611 cholera deaths, being at the rate of 37 to
10,000 living, In the 39,726 houses supplied by the
wark & Vauxhall Company, comprising a population of
268,171 persons, there occurred 3,476 deaths, being
rate of 130 to every 10,000 living."

"The population drinking dirty water accordingly a
to have suffered three and a half times as much mo
as the population drinking other water."

"But this evidence is only a part of the case; it adı
being greatly strengthened by a second group of facts
the statistical tables exhibit. It was thought proper
how far any discoverable influence of foul water had
constant to both occasions; and this comparison is of si
interest for our purpose, because the Lambeth Con
which in 1854 gave the superior water, was in 1848–

veying even a worse supply than that of the Southwark & Vauxhall Company."

"It has already appeared that the tenantry of the Lambeth Company lost by the epidemic of 1853–4 611 persons. By the epidemic of 1848–9, in the same houses (or rather in as many of them as then existed), the deaths were 1,925." "The earlier figures showed that this population suffered in 1853–4 not a third as much as its neighbors; the present figures give the further fact that it suffered also not a third as much as at the time of its unreformed water-supply."

"Since the epidemic of 1853–4, the Southwark & Vauxhall Company, in obedience to the Metropolis Water Act, has abandoned its former very objectionable source of supply, and for the last few months [May, 1856] has been distributing a water nearly or quite identical in quality with that spoken of as furnished by the Lambeth Company."

"It entirely consists with the facts here set forth to maintain that, under the specific influence which determines an epidemic period, fecalized drinking-water and fecalized air equally may breed and convey the poison, and that this, whether in one vehicle or the other, may be expected to prevail most forcibly against the feeble and ill-nourished parts of a population."

It may be added that the evil effects of much-polluted water as compared with water but little polluted, which become so palpable and distinct in a time of epidemic, cannot cease to exist except in degree when no epidemic prevails. According as the river-waters are cleansed from the impurities which now are expected to hide themselves there, the general health of all living things depending on them and using them, whether in the shape of drink or food, must be benefited.

The cholera reappeared in London in 1866, June, July and August, and called attention again to the character of the water-supply by the "explosion," as it was called (from the sudden and fearful increase of deaths), in that district of London supplied from the pipe-mains of the East London Water Company.

This company derived its water from the River Lea, at a point above Tottenham Mills. The water there passes into

large open settling reservoirs. Moving slowly through and depositing there the heavier portion of any impur suspension, it is carried by an open canal about three n length, to the filter-beds below Lea Bridge. After fil it is carried by a four-foot pipe, two miles in length, pumping station at Old Ford, where it is received ii covered reservoirs in communication with the pumping (there. It is to be noted that there is one large pumping at Lea Bridge on the site of the filter-beds. At Ol there are four pumping engines.

"Of the total mortality from cholera in this visitat 5,548 souls, no less than 3,909 occurred in the East D alone." The population in this case will be a better ind of the condition than the relative area. The popula London for 1866 was 3,037,991; the population of tl London Districts was 598,945, leaving 2,439,045 for t of the metropolis. "No relative development of like tude, suddenness and shortness of duration has occu previous outbreaks of cholera in the metropolis." Nor able to trace the great excess of deaths to density of] tion. "In the recent outbreak, as in previous out there was no relation between the density of popula expressed by numbers of persons per acre and the in of prevalence of the disease."

The following table shows the weekly deaths:—

Cholera of 1866. Weekly Deaths.

Week Ending—	In the East District (598,945 population).	In the rest of London (2,439,046 population).	Week Ending—	In the East District (598,945 population).
July 7, . .	9	5	Aug. 25, . .	198
14, . .	20	12	Sept. 1, . .	122
21, . .	308	38	8, . .	74
28, . .	818	86	15, . .	77
Aug. 4, . .	916	138	22, . .	56
11, . .	673	108	29, . .	55
18, . .	369	86		

The exaggeration of the death-rate over the grou plied by the East London Water Company led to t

picion that the water must be in fault. At Old Ford, beside the two covered reservoirs receiving the filtered water from Lea Bridge, there were two uncovered reservoirs full of unfiltered water; that water being likewise decidedly more impure than the water drawn from the Lea at the point of in-take four miles up the river. The water in these uncovered reservoirs was drawn in part directly from the Lea near by, by soakage. "The river at this part of its course, in June and July, 1866, was a cesspool as well as a canal, for it then received the sewage of the large population inhabiting Old Ford, and the greater portion of Bromley and part of Mile-end." One of the covered reservoirs had a connection with the open reservoirs, and when the filtered water was deficient, the unfiltered water could be drawn from the open reservoir to meet the requirements of the pumps. It was ascertained that some water from these open reservoirs had been used, and to this mixture of a water, which, beside being unfiltered was in other respects much less clean, with the ordinary supply, this exaggeration of the cholera in this district was ascribed. The amount of bad water used seems to have been small, and yet the effect was fearful. Mr. Radcliffe believes that the fecal discharges from some cholera-patients emptied into the Lea there, reached and affected the waters of these open reservoirs.

In corroboration of the belief that the water at Old Ford was contaminated in this way, and was the cause of the explosion of disease, the water delivered by the pumping engine at Lea Bridge, drawing its water directly from the filter-beds, did not produce this effect over the ground supplied by this engine.

The mixture of impure water at Old Ford had occurred frequently before with no perceptible effect on the population supplied. It was only on the occasion of an epidemic that the additional impurity made itself understood. Have we not reason to infer again that, as the waters furnished to London become less polluted than they are now, the general salubrity of the place will markedly improve, and the visits of an epidemic become less and less severe?

All that has been said thus far, although at times apparently contradictory, may be epitomized as follows:—

To those who are willing to risk a certain measure of river-pollution, and who would disregard the warnings of epidemics,

the London supply from the rivers Thames and Lea, c
referred to and quoted as being sufficiently safe for all
in healthy times, and under careful management and
tion, notwithstanding the pollutions to which these st
are known to be exposed.

To those on the other hand who would not expose th
lic health to any risk that can be avoided, and who l
that the gradual emancipation now in progress of the
Thames and Lea from sewage and other impurities wi
tainly improve the health-rate of that metropolis, and
it measurably from those exceptional visitations of si
from which we can never expect to be wholly exem
such, it is believed that the same course, as far as prac
should be pursued with regard to the rivers of Massacl
and that pollutions of all kinds should be, as far as p
prevented hereafter from passing into them, and that t
pollutions now flowing into them should be intercep
deodorized as far and as speedily as may be practica
that the waters may be gradually restored, and held,
amount of cleanliness at least, which will admit of the
used as fair river waters are used in the arts and manuf
in which fish will live and thrive, and which animals
refuse, although the restoration might not always be s
to make the water safe for domestic use.

It is to be remembered of the rivers that rise wi
State, that their waters are small in volume as compa
the Thames River. They have, besides, more fall p
present more frequent opportunities for water po
much more occupied generally by mills for their
of water, and will therefore have a denser manufactu
ulation on their banks. The refuse from the various
factories may be expected speedily to render these
small volume in summer) unfit for use, and in this r
below the standard of the Thames water.

Some of the smaller rivers in England, as the
and the "Calder," have run this course, are now b
manufacturing pollution, and have been long unfi
domestic use.

Part II. — Statistics, Etc.

We present now in tabular form the general statistics of the river-valleys examined, and have added those of some English rivers, as far as they can be ascertained, for comparison. (See page 38.)

From this table it will be perceived that, except on the Blackstone River, there is but little concentrated sewage. On the other rivers examined this season, a certain amount of sewage reached the rivers from the factory-operatives' and from other houses near the river-banks. On the Blackstone, the sewage of the city of Worcester is added to this factory-sewage. The fluid refuse from the factories, therefore, some of it very poisonous, produced in the processes of cleansing and preparing the manufactured article, whether paper, cotton cloth, woolen cloth, leather or otherwise,—this refuse forms the chief element in the pollution of these streams.

The following brief statement, explanatory of the kinds of chemicals and other materials used in the many processes of the different manufacturing works referred to, will enable the reader to form some idea of the objectionable character of the fluid refuse resulting from them. This statement has been prepared for me by Mr. L. B. Ward, chiefly from English reports, with some references to present differences in our own practice:—

Woolen Manufacture.

The cloth-manufacture includes all the processes to which the raw material is subjected, whatever the fabric that is made, whether fine or inferior cloth, flannels, blankets, or carpets. The wool is deprived of its natural grease and foreign matters, and thereafter dyed. It is then supplied with oil or other lubricant, which is washed out of it after it has served its purpose of conferring the necessary softness and flexibility for spinning and weaving; and thereafter it is fulled and felted, scoured and dried. Some of these steps in the manufacture are omitted in some places and for some purposes, and there are various modes of conducting them. (See page 39.)

	MASSACHUSETTS RIVERS.					ENGLISH RIVERS.			
	Chicopee.	Blackstone.	Taunton.	Neponset.	Charles.	Thames.	Lea above Hertford.	Calder.	Ribble.
Drainage-area of basin, square miles,	718	276	447	116	296	3,676	244	366	644.5

	NAME OF PLACE ON THE RIVER BY WHICH THE GIVEN AREA IS LIMITED.								
	Chicopee Village.	Blackstone.				Hampton.	Hertford.	Mouth.	Preston.
Dry-weather flow per diem, at the last point, cubic feet,	12,407,040	5,961,600				52,252,000	4,332,340	6,120,500	13,135,700
The same in U. S. gallons,	92,804,659	44,592,768				390,870,000	32,408,640	45,764,400	98,261,600
Number of mills or polluting factories on the river and its branches.	72	85				360	32	3,178	52
Number of ries per sq	.10	.30				.098	.131	8.683	.0807
Number of operatives in these factories, per square mile of basin,	11	30				-	31.4	-	30.9
Population of the basin within the given area,	1875. 55,015	1875. 80,638				888,068	73,526	432,992	387,839
Population of the same per square mile,	76.5	292				241.6	301.3	1,183	601.7
The portion of the population known or supposed to be sewering into the									

Estimates of the Waste Stuff from the Manufacture into Cloth of Thirty Tons of Wool (67,200 lbs.).

MATERIALS USED OR EXTRACTED COMPOSING THE REFUSE.	ESTIMATE No. 1.		ESTIMATE No. 2.	
	Tons.	Cwt.	Tons.	Cwt.
Grease, . } removed from raw wool, .	8	-	10	-
Dirt, . . } removed from raw wool, .	4	-		
Urine, ...	14	-	15	-
Oil, in carding, ...	2	-	2	-
Glue, ...	-	10	-	7
Pigs' dung, ...	2	10	1	10
Pigs' blood, ...	2	5	-	-
Urine (second use), ...	25	-	-	-
Soda, ...	1	-	-	15
Common salt, ...	-	-	1	10
Soap, ...	2	10	-	15
Fuller's-earth, ...	2	10	-	8
Dyestuffs, ...	20	-	21	-
Alum, ...	2	-		

A complete list of the several processes which short wool undergoes in the manufacture of fine cloth, includes upwards of forty successive steps between the fleece and finished goods.

The use of water occurs at least ten times throughout this series of operations,—in the first scouring and washing of the wool, in woading, washing, and dyeing, and again washing in segging ("segging"; *i. e.*, soaking in a lye of soda and urine), fulling and washing the woven piece, and in roll-boiling and a last scouring. In the first washing of the sorted wool, in the washing after dyeing, and in washing the web both before and after fulling, the water leaves the wool-mill charged with grease and oil; united with the soda and ammonia of the various detergent substances, such as urine and pigs' dung, which have been employed; charged, also, with the waste coloring matters it can carry off. From certain of the washing waters, in which the oil and grease, saponified and taken up, are present in sufficient quantities to make the process of recovering the oil remunerative, a certain proportion of the oil purchased by the manufacturer is recovered.

The first process giving rise to pollution is that of washing

the wool. The fibres of wool as they come from the ba the sheep, even though it had been washed before it shorn, are covered with a brownish greasy matter, the re left behind on the evaporation of perspiration. As a the finer the wool, the larger the proportion of this re of perspiration which it contains. Thus, from one-h nearly two-thirds of merino lamb's-wool consists of offensive material, whilst ordinary qualities contain about one-third of their weight. From one-half to third of the grease is of a waxy nature, and is left wool after the washing and scouring operations.

The raw wool is boiled in probably, on the averag its weight of urine, beside about one-twentieth of its of other detergent substances (soda-ash, phosphate of and salts of ammonia), pigs' dung being sometimes em instead of, or in combination with, the urine. All o are afterward carefully washed out of it, and the whol filthy scouring liquid, as well as the washings, pass i stream.

The next process in the manufacture of "superfine cloths, as practised in the west of England, is woading* the wool, which consists in steeping the pr washed wool for twenty minutes in a liquor prepared ing four parts of indigo to 1,000 parts of water. Th indigo-liquor is used for a year or more withou renewal than the addition to it weekly of five pc indigo for each 1,000 pounds of raw wool manufactu

The woaded wool is next washed in running wate of course carries off a certain quantity of the coloring

In the second stage of the dyeing process, sixty p dyewoods with fifty pounds of alum and ten pounds (crude bitartrate of potash) are required in the tre 400 pounds of the woaded wool. The wool having b out of the second dye-vat, the liquor in which it steeped is run to waste; the wool is by some dyers nov by others it is left unwashed. The vat is then ref pounds of logwood, with a proportion of other dyew certain amount of nitro-muriate of tin in solution bei in it. After the same weight of wool has been boil

* So called from "woad," a plant formerly used in this process in plac

liquor for an hour, it is removed and well washed in running water, being then fully dyed. The contents of this vat are also run to waste.

The volume of spent dye-liquor from the manufacture into fine black cloth of 1,000 pounds of raw wool, may be set down at 6,000 U. S. gallons. This waste liquid is the great source of pollution, so far as the appearance of the rivers is concerned.

The washed wool receives, after being dried, about one-eleventh of its own weight of sweet-oil before being carded; and after being spun, the thread is passed through a weak glue before weaving. After weaving, all these matters are taken out of the web by soaking and kneading it in a mixture of urine, pigs' blood, pigs' dung and soda; and, after being washed free from all these detergent substances, it is fulled along with about twelve pounds of soap per piece of cloth, a process which felts the material together, and causes the threads to shorten. Some two or three pounds of fuller's-earth are subsequently used, and this, with all the soap, is then washed out. The subsequent use of water, as in roll-boiling, is not attended with any further drainage of filthy material from the works.

The difference between the estimates of waste stuff, which have been given in the table, is principally in the use in the former of them of so large a quantity of pigs' dung, pigs' blood and urine in the scouring process before fulling. This, however, it is believed, still represents the ordinary practice.

Comparison of the Liquids Wasted from Woolen-Factories.

DESCRIPTION.	IMPURITIES PRESENT IN 100,000 PARTS.			
	Solid matters in solution.	Mineral matters in suspension.	Organic matters in suspension.	Total impurities.
"Wool-suds" in which raw wool has been scoured, . . .	1,099.4	870.95	2,611.65	4,582.
Waste liquor from dye-vats, .	107.6	24.08	77.92	209.6
Washing water from dyed and scoured goods, . . .	29.62	.72	.88	31.22

Cotton Manufacture.

The operations carried on in bleaching, dyeing and print ing calicoes, involve the pollution of large volumes of wate partly by mineral, but chiefly by organic matters. In mo cases the coloring matters, which it is the object of the man facturer to fix upon the tissues, are contained in but ve small proportion in the dyestuffs employed; thus the weig of actual coloring matter in one ton of madder is not m than two and a quarter pounds; hence nearly the whole these dyestuffs is refuse matter, which, partly in soluti and partly in the solid condition, is carried by the goit* of mill into the adjacent stream. According to careful exp ments made on this point, only twenty-five per cent. of madder used for dyeing goes into the stream in a stat suspension; the remainder, being rendered soluble in processes of dyeing and garancine making, conseque enters the stream in solution, hence the large proporti organic carbon and organic nitrogen in solution in the eff water.

The following is a list of the chief materials commonly in works for printing and dyeing calico:—

Dyestuffs, and adjuncts thereto:	*Chemicals:*
Madder or Garancine (prepared madder).	Sulphuric acid.
Peachwood.	Muriatic acid.
Logwood.	Soda-ash.
Sumach.	Bleaching-powder.
Cows' dung.	Lime.
Starch.	Soap.
British gum.	Arsenate of soda.

With the exception of a small proportion of the m and of the starch used in stiffening the finished good chemicals find their way into the stream, since they in scouring, washing, and cleansing, and are not con the goods sent out of the factory. We may gain s

* Or go-out; *i. e.*, sluice-way.

of the extent of the pollution arising from the processes in question, by considering the annual consumption of dyestuffs, chemicals, and other materials in one such factory of about average size, employing 250 hands, viz. :—

Quantities of Materials used Annually by the Kinder Printing Company.

Dyestuffs, Etc.	Pounds.	Chemicals.	Pounds.
Madder, . .	560,000	Sulphuric and muriatic acids, . .	280,000
Peachwood, .	8,512	Soda-ash, ...	112,000
Logwood, .	58,240	Bleaching-powder, ...	31,360
Sumach, . .	17,696	Lime, ...	67,200
Cows' dung, .	127,680	Soap, ...	98,560
Starch, . .	109,760	Liquid arsenate of soda, containing 833 pounds metallic arsenic, .	42,560
British Gum, .	42,560		

The quantity of polluted water sent out from these works is estimated at 600,000,000 United States gallons per annum, the refuse matter with which it is charged amounting to 1,446,000 pounds.

The use of arsenate of soda in printing and dyeing calico demands especial notice. It is seldom included in the returns of materials used, but it is well known to the trade that its employment is now almost universal in all descriptions of madder-dyeing.

In order to fix the coloring matter of the madder-root upon calico, it is necessary first to impregnate the latter with a material called a mordant, with which the coloring matter subsequently combines chemically, forming an insoluble compound which cannot be removed from the tissue by washing.

After the application of the mordant to the calico, it is necessary to remove the excess, and also to render the remainder and really useful portion, which has penetrated into the interior of the cotton-fibre, absolutely insoluble in water. Both these objects are effected by an operation technically called "dunging," because formerly the mordanted calico was passed through a hot bath containing an emulsion of cows' dung. It was subsequently found that the dung-bath could be advantageously replaced by a solution of phosphate of soda

containing some phosphate of lime and sulphate of lime in suspension, the requisite material being manufactured anc sold under the name of dung-substitute. Finally, about twenty years ago, it was discovered that arsenate of soda increase both the economy and the efficiency of the dung-bath, and mixture of cows' dung and arsenate of soda appears to hav now, to a great extent, superseded the older mixtures in th part of the calico-printing process.

Arsenate of soda is a compound of arsenic acid and sod containing about thirty-three per cent. of metallic arsen and is a virulent poison.

Turkey-red dyeing is a special process for dyeing cal with madder, largely carried on in Scotland. The color fi by it is celebrated for brilliancy and strength. For the p pose of showing the polluting power of works in which process is practised, the following table is given of the qu tities of the principal materials used in one year, anc bleaching and dyeing 1,080 tons of yarn and cloth, factory in which 750 hands are employed.

Materials used in Turkey-red Dyeing.

Garancine, .	1,080,000 pounds.	Alum, . .	678,000 pou
Sumach, . .	540,000 "	Soda, . .	1,080,000
Blood, . .	1,782,000 "	Soap, . .	345,600
Olive-oil, . .	678,000 "	Water, . .	693,600,000 U.

One-half of the olive-oil, or its products of oxic remains in the goods at the completion of the dyeing pı

The comparison of analytical results in the followin shows that the drainage from Turkey-red works cont much larger proportion of arsenic than that from d print works.

Analyses of Waste Water from Calico Dye and Print-Works.

DESCRIPTION.	IMPURITIES PRESENT IN 100,000 PARTS.							
	Dissolved Matters.				Suspended Matters.			
	Total Solid Matters.	Organic Carbon.	Organic Nitrogen.	Metallic Arsenic.	Mineral.	Organic.	Total Suspended Matters.	Total Impurities in 100,000 Parts.
Drainage from calico dye and print works. Av'ge of five works.	50.2	4.226	.299	.034	7.02	18.97	25.99	76.2
Drainage from Turkey-red works, . . .	66.8	3.471	.510	3.200	27.76	11.12	38.88	105.7

Bleach-Works.

Bleaching operations are usually carried on in calico print-works, but also occasionally in separate factories. The pollution arising from them appears to be of a comparatively slight character, consisting chiefly of alkaline and slightly soapy liquids, solution of chloride of calcium, sulphate of lime in suspension, and traces of chloride of lime in solution; these are copiously diluted with water used in washing the bleached calicoes.

Additional as to "Cotton-Bleaching."

A communication from Edward Schunck, F. R. S., bleacher and dyer of cotton yarns and calicoes, given on page 158, vol. 2 of the Report on the Mersey and Ribble Basins, 1870, furnishes the following details relative to the bleaching process.

"It is well known that nothing is added to cotton-fibre previous to or during the process of spinning into yarn, but that on the contrary mechanical impurities, such as fragments of seed vessels, are to a great extent removed. During the process of yarn-bleaching, however, about five per cent. by weight of matter, inherent in the fibre, is removed from the cotton. This matter is for the most part dissolved by the soda-lye with which the yarn is in the first place treated.

The product of this treatment is a dark brown liquid, which is of course allowed to flow into the nearest stream.

The substances removed by this treatment are, principally, pectine, organic coloring matters, and fatty acids. These, when allowed to pass into streams, produce only slight evil effects beyond the brown coloration which they impart to the water, because they are bodies which are only slightly capable of undergoing putrefactive decay. Their alkaline solutions, when allowed to stand exposed to the air, are after some time found to be covered with mold, but never become foul or stinking. The only substance removed from cotton by treatment with alkali which is liable to putrefaction, is a minute and almost inappreciable trace of albuminous matter.

During the succeeding stages of the bleaching process, the yarn is treated with chloride of lime, then with sulphuric acid, several times in succession. These materials, after effecting the purpose for which they are intended, are passed in a state of solution into the streams.

All that has been said regarding the bleaching of cotton yarn applies also to the bleaching of calicoes, with this addition, that the alkaline liquid resulting from the treatment of piece-goods with soda and lime contains a quantity of nitrogenous matter derived from the flour-dressing which is always used in preparing the yarn before weaving."

Linen and Jute Manufacture.

The chief operations in this branch of industry which affect running water are, 1st, the bleaching of linen and jute; and 2d, the dyeing of these fibrous materials.

The process known as flax-steeping, consists simply in placing the flax in a pit filled with water long enough to cause the partial putrefaction of the stem, or of those softer portions of it which hold its fibre and woody part together. This process is conducted on the farms where the flax is grown, and will not be farther noticed here.

Linen and Jute Bleaching.

The operation of bleaching linen differs very widely from the corresponding processes applied to calico; for, whilst the pollutions caused by the latter are, as has been said, of a

comparatively slight character, those of the former constitute one of the most formidable sources of water-nuisance with which we have become acquainted. At every stage of the treatment of flax with water, from the first steeping of the plant to the final finishing of the manufactured goods, linen fibre, unlike that of cotton, appears to yield to water and solutions of various chemicals, again and again, large quantities of soluble organic matters of great polluting power.

The fibre received by the bleacher is first steeped for about a fortnight in tubs of water, at the end of which time the water from the tubs is discharged into the neighboring stream; the fibre is next steeped overnight in a caustic soda-lye, which is run off into the stream early the following morning. The bleaching proper, which is performed chiefly by the use of chlorine, is commenced after the fibre has been spun, and, so far as it relates to the fouling of the streams, is completed before the cloth is woven.

The bleaching process varies somewhat in different establishments, but the following description embodies all its essential features as carried out in the factories in the vicinity of Dundee, in Scotland, where is afforded one of the best illustrations of river-pollution arising from this cause.

One thousand and eighty pounds of linen and jute-yarn, 180 pounds of soda-ash, and 10,000 pounds (1,200 U. S. gallons) of water are put into a capacious caldron and boiled for some hours. The liquor from this first boiling is excessively offensive, and highly polluting, yielding upon analysis 257 pounds of dissolved and twenty-two pounds of suspended matters, exclusive of the weight of the alkali. The yarn is similarly boiled a second time, but with only one-fifth of the above-mentioned quantity of soda-ash. The liquor produced even by the second boiling has a polluting power at least twenty times as great as that of ordinary town-sewage; the impurities in it amounting to forty-three pounds more than the weight of the alkali, the loss of organic substance from the yarn in the two boilings thus being thirty per cent. of its original weight.

After washing in water, the bleaching process is continued by immersing the yarns in a solution of chloride of lime, then in dilute sulphuric acid; the object being to liberate chlorine from the chloride of lime, with the solution of which the

fibres are saturated. From the acid-vats the goods are transferred to a solution of carbonate of soda mixed with soap, for the purpose of neutralizing the sulphuric acid. This series of operations needs to be frequently repeated to obtain the necessary whiteness. The waste, polluting products from all these operations are discharged in an unpurified condition into the stream. They are, 1st, the caustic-soda lye; 2d, waste chloride-of-lime liquor; 3d, waste sulphuric-acid liquor; 4th, waste carbonate of soda and soap-liquor.

Returns from eight of these factories, consuming annually 10,000,000 pounds of mineral chemicals, show that to each 1,000 pounds of yarn there is used on the average, viz.:—

Pounds chloride of lime,	197
soda-ash,	68
sulphuric acid,	43
Total pounds,	308

Goods weighing in the aggregate 32,500,000 pounds, are annually bleached at these works, yielding an amount of organic impurities estimated at not less than that of the chemicals used (10,000,000 pounds).

Jute-Dyeing.

The polluting liquids arising from the dyeing of linen and jute are essentially the same as those produced in the calico industry.

Before being submitted to the process of dyeing, jute is first carded, rove, and spun, operations in which water is not required; some train-oil is, however, mixed with the fibre, which, on being subsequently washed or scoured out, contributes to the pollution of the general drainage of the works.

If the spun jute is to be dyed of a bright color, it requires to be first bleached in the mode already described; but black and dark colors are imparted to the unbleached material.

The colors chiefly used are those technically known as "spirit colors" among calico-printers; they consist of decoctions of dyewoods to which chloride of tin is added. The hanks of spun jute are immersed in these liquids, and afterwards washed in water.

Blacks are dyed with logwood and copperas, or nitrate of iron; reds with Lima-wood; yellows with turmeric, fustic, or quercitron bark; and browns with catechu, to which some sugar of lead is added. Prussian blue and aniline colors are also to some extent employed as dye-wares.

The sample of mixed liquid of which the analysis is given below, was taken from the general drainage of an extensive manufactory of jute and flax goods, in which the operations of bleaching, printing and dyeing are carried on together; the annual consumption of dye-wares is 350,000 pounds, and of bleaching substances 542,000 pounds. Fifty-five million seven hundred and twelve thousand U. S. gallons of foul water are annually produced from washing, printing, and bleaching, and 26,656,000 gallons from dyeing processes.

Analysis of Waste Water from Jute Dye-Works.

DESCRIPTION.	Dissolved Matters.				Suspended Matters.			Total Impurities in 100,000 Parts.
	Total Dissolved Matters.	Organic Carbon.	Organic Nitrogen.	Chlorine.	Mineral.	Organic.	Total Suspended Matters.	
Drainage from works, .	236.5	9.619	.529	42.8	17.84	35.32	53.16	289.7

Silk-Manufacture.

The polluting liquids discharged from silk-works do not differ essentially from those issuing from calico and woolen works; but the degree of pollution is considerably less in the former, whilst the volume of liquid is comparatively insignificant.

To prepare raw silk for dyeing, the gum which naturally adheres to the fiber is removed by boiling with a solution of soap. The gum constitutes about twenty-five per cent. of the weight of the silk; and about twenty pounds of soap are used for discharging the gum from one hundred pounds of silk. Altogether, about forty pounds of soap are used for each one hundred pounds of silk, and all the suds are habitually thrown into the stream. The dyes used are chiefly those known as aniline colors, and being very expensive, and capable of being

applied to the silk almost without waste, but little goes into the rivers.

One hundred thousand parts of waste water from silk print-works, on analysis, yielded 26.50 parts of "total solid matter in solution."

Paper-Manufacture.

The manufacture of paper, as usually carried on, consists of two principal processes: the first, that of preparing the pulp; the second, that of spreading this pulp into sheets. The latter of these is a merely mechanical process of rolling, drying, pressing, etc.; it is only in the first part of the manufacture, therefore, that any nuisance or injury to rivers can arise.

The preparation of pulp is an operation partly chemical and partly mechanical, and varies with the nature of the raw materials employed, and the quality of paper to be made. The materials upon which the paper-maker has hitherto principally depended, are cotton and linen rags, either white or colored, old ropes, canvas bags, and cotton waste. More recently the demands of the manufacture have led to the introduction of other descriptions of fiber; in Great Britain, the alpha or esparto, a species of sedge which grows in the wild state in parts of Spain and Northern Africa bordering on the Mediterranean, has been extensively adopted within the past fifteen years; in the United States, the coarser portion of the stalk of the plants which affords the jute-fiber has been found a cheap and serviceable substitute for rags. The other crude fibers employed by the paper-maker which require notice here are obtained: first, from straw which is frequently used, and with considerable advantage, in connection with linen and cotton rags, in the production of printing-paper; and second, from wood of various kinds, the use of this material being, however, limited.

For the manufacture of writing and printing papers, nothing has yet been discovered to greatly lessen the value of rags, which possess, also, the great advantage of having been repeatedly prepared in advance for paper-making by the numerous alkaline washings which they necessarily receive during their period of use.

Whatever the raw material may be, it is necessary to dissolve out of it, by means of alkaline solutions and heat, an amount of organic refuse-matter which would be inadmissible in the pulp. In the crude fibrous substances esparto, straw, jute and wood, the organic matters required to be thus separated from the fiber consist chiefly of vegetable albumen, resin, gum, fatty and coloring substances, and the silica always present in combination with a coating of raw fibers. The process employed, and the refuse-liquor produced, are chemically entirely analogous to the flax-steeping and linen and jute scouring processes and the refuse resulting from them.

The organic matters to be eliminated from ordinary rags, are partly of animal and partly of vegetable origin, and include fatty and glutinous substances, fibers of wool or silk interwoven with those of the cotton or linen, and the coloring materials of the dyer. A certain proportion of these are separated as "rag-dust" in the preliminary operations of "cutting" and "dusting"; the remainder disappears in the treatment with alkali in the form of liquid refuse, with which alone we have to do.

The following table is intended to show the comparative polluting power of the principal articles used for paper-stock, and the proportion of useful product obtainable from each:—

Organic Refuse and Useful Fiber in 100 Parts, Dry Weight, of Paper-Stock.

DESCRIPTION.	Useful Fiber.	Dry Refuse.	Liquid Refuse.
Fine white rags,	85 per cent	9 per cent.	6 per cent.
Colored cotton rags,	76 "	12 "	12 "
Esparto,	60 "	-	40 "
Jute "butts,"	70 "	-	30* "
Wheat straw,	52 "	-	48 "
Oat and rye straw,	47 "	-	53 "
Poplar-wood, seasoned,	37 "	-	63 "

* Becomes 50 per cent., if bleached fully.

The first chemical operation to which the raw material is subjected, is that of boiling in an alkaline solution at a high temperature, for the purpose of extracting or destroying the

fatty, glutinous, and coloring substances surrounding the pure fiber which is needed by the paper-maker. There are differences of opinion and practice as to which of the alkalies should be used, as to the quantities required, and as to the best mode of combining their action. The crude organic matters present in straw, esparto, and wood are found to yield most readily to a strong solution of caustic soda, and in Great Britain this alkali is made use of, also, for boiling rags.

The soda-lye is prepared: 1st, from so-called caustic soda-ash, in which from one-fifth to two-fifths of the contained alkali is in the form of hydrated caustic soda; 2d, from soda-crystals, pure hydrated carbonate of soda, containing about twenty-two per cent. of actual soda; or 3d, from soda-ash, the crude carbonate of soda, containing at the standard strength forty-eight per cent. of actual anhydrous soda,—the last being the most generally used.

The caustic solution is obtained by boiling the crude carbonate (soda-ash) with quicklime,—one hundred pounds of soda-ash requiring to be treated with forty-three pounds of pure, freshly-burned lime. In some paper-mills the lime and soda are put into the boiler with the paper-stock, to which water is then added; but the common practice is to prepare the caustic solution in a separate vessel, in which the mixture is allowed to settle, the clear liquor being then used for boiling the paper-stock. When this course is followed, the lime which has been converted into an insoluble carbonate is commonly mixed with water and run to waste, being the first liquid refuse produced.

The caustic soda-solution is not invariably used for cleansing the fiber: in the practice of the American paper-makers, caustic lime is substituted for it in the digestion of ordinary rags. This alkali is believed to be less injurious than soda to the fiber, while it has the property of combining with the various fatty and other substances present in the rags, with which it forms insoluble calcareous soaps. From five to fifteen per cent. of lime is required where it is used by itself. Where colored rags are operated upon, the treatment includes a second boiling, with two per cent. of soda, for the removal of coloring substances which do not yield to lime alone.

When writing or printing paper of good average quality is

to be made from any of the raw materials which have been named, alkalies are required for their preparation nearly as stated in the table inserted below. The proportion of alkali varies, not only with the nature of the materials used as paper-stock, but also with the quality of the manufactured product.

Alkalies used for Digesting 100 pounds of Paper-Stock.

Raw Materials of Paper-Stock.	Soda-ash containing 48 per cent. of soda—pounds.	Caustic lime—pounds.	Total alkalies—pounds.
White rags,	3	8	11
Colored rags,	2	13	15*
Esparto,	17	7	24
Straw or jute,	25	15	40
Jute "butts,"	-	25 to 50	25 to 50†
Wood,	100	60 to 100	160 to 200

* Lime followed by soda. † Unbleached product.

Next to the fouling of water by the washing of filthy rags, the discharge into rivers of the soda-liquor in which esparto has been boiled, is the most formidable source of pollution from paper-mills. During the process of digestion, which is usually carried on in large wrought-iron boilers in which a temperature considerably above that of boiling-water is maintained by means of high-pressure steam, the soda combines with the silica and resinous matters to form soapy compounds. The resulting liquid, technically termed "boilings," is of a dark brown color, approaching to black, and is so soapy in its nature that one volume of it added to two thousand volumes of pure water, produces on agitation an extremely persistent lather or froth. The "coolings," as the cold water is termed which, upon the removal of the "boilings," is injected into the boilers for the purpose of cooling and partially washing the fiber, is a diluted form of the same liquor. A river polluted by these waste liquors has been known to carry a froth or scum over its whole surface for long distances, and which has accumulated at some points to a thickness of four or five feet. An analysis of this polluting liquid is given for reference.

Analysis of Waste Esparto Liquor Impurities in 100,000 Parts.

Total solid matters in solution,	4,038 00
Organic carbon,	939.84
Organic nitrogen,	77.04
Ammonia,	1 12

When the process of boiling, which in the case of straw or esparto occupies many hours, is concluded, the alkaline liquid is allowed to drain off, and the fiber is transferred to the "engines," to be washed and "pulped." The fiber is now subjected to the action of running-water, aided by the movement of certain rollers and drums coated with wire gauze. The main object of this operation is to remove the alkali, together with the matters which it holds in solution; but it effects also changes in the mechanical condition of the fiber, which, although very important to the paper-maker, have no special bearing upon the subject under consideration. The time required for washing esparto is from twenty-five to sixty minutes, according to the paper required; the quantity of water employed for each one thousand pounds of the raw material probably averaging five thousand United States gallons. Rags occupy from three to six hours' time, and require a proportionately larger quantity of water.

The liquid from the washing-engines differs from the boilings in having a very much smaller quantity of mineral and organic matters in solution, and consequently being much less frothy, as well as in containing considerable quantities of suspended matters, chiefly useful fiber. The following figures give the average of a number of analyses of waste washing-water, the specimens having been taken at intervals during the process, which, as the water is continually passing in and out of the engine, is one of progressive dilution.

Composition of "Washings" from Paper-Works. Impurities in 100,000 Parts.

Organic matters in suspension,	81 25
Mineral matters in suspension,	10 50
Organic and saline in solution,	95.75
Total,	187.50

The waste alkaline liquor from the boiling process, with all matters dissolved by it from the rags, straw, esparto, etc., and the water from the washing-engines, constitute the second liquid refuse from the paper-manufacture, the first being the lime-residuum from the soda "causticising" process already described.

When the washing is completed, the pulp, if intended for white or slightly colored paper, is bleached by means of chloride of lime. The solution of bleach only is employed by paper-makers, and a quantity of solid refuse consisting of lime accompanied by undecomposed bleaching-powder and similar compounds remains in the vats in which the chloride of lime has been treated. This residuum is deleterious to fish, and should on no account be admitted into running waters.

The clear bleach-liquid is brought into contact with the pulp, and left so for some time; the chlorine of the bleach then slowly exhausts itself in the destruction of the coloring matter of the pulp.

The quantity of bleaching-powders (chloride of lime) required for one thousand pounds of paper differs with the nature of the raw material, and varies for each according to circumstances.

Raw Material of Paper-Stock.	Pounds Chloride of Lime per 1,000 lbs. of Paper.
Linen or cotton rags,	35 to 140
Straw,	150 to 250
Esparto,	200 to 400

Certain chemicals are added to the bleach-liquid after it is brought into contact with the pulp, in order to increase the energy of the bleaching-powders; alum being used by some paper-makers, and sulphuric acid by others, for this purpose. The first of these requires to be used in the largest proportion; its weight amounting sometimes to nearly one-tenth of that of the paper.

After the conclusion of the bleaching process, the liquor from it ought to contain but a very small proportion of chlorine

capable of being set free by the addition of sulphuric acid; nor should any great excess remain in the pulp to require subsequent washing out.

The spent bleach-liquor constitutes the third liquid refuse from the paper-manufacture.

The pulp has now to undergo further important mechanical treatment, which does not, however, require special notice here; and after having, in the case of printing-papers, received an addition of "size," composed chiefly of alum, soda, and resin, is finally ready to be dealt with by the machine for the formation into lengths of paper.

The fourth liquid refuse from the paper manufacture consists of the waste waters from the making-machines.

They are considerable in quantity and, as a rule, highly charged with fibrous and saline matters, which sometimes amount to $\frac{1}{850}$ part of their weight; where printing-paper is made, the "size," which is in solution in these waste waters, usually renders them very frothy.

It will be seen that refuse arises in the manufacture of paper at the following stages:—

1. The dusting process.
2. The lime-refuse from the treatment of soda.
3. The alkaline waste liquors from the boiling process.
4. The insoluble part of the bleaching-powders.
5. The waste bleach-liquor, if used in excess and without due caution.
6. The drainage of the making-machines.

Of these, the first, second, and fourth may be excluded from the drainage without difficulty. Among the other forms of refuse specified, the third is at once a source of injury the most serious and the most troublesome to dispose of. With the exception of the small portion of the liquid which will drain off, no attempt is usually made to deal with this refuse except by the prolonged washing in the engine, which washing employs so large a portion of water that it has been supposed to be practicably impossible to deal with it subsequently, and it has therefore been thrown directly into the river. On

this point it is also to be observed that the alkaline waste liquors from the digestion of fine rags average but about one-tenth of the strength of those yielded by the treatment of esparto or straw.

The amount of polluting refuse arising from the manufacture, as it is carried on in paper-works of the highest class, will be best learned from the actual examples contained in the appended statements of the operations of four establishments situated on the same stream (the North Esk) in Scotland. Certain methods of purification which have been adopted in these and other paper-mills upon the same stream, have had the result, it is stated, of diminishing the pollution due to the discharge into it of liquid matters, 75 per cent., without taking into account matters properly classed with dry refuse.

North Esk Paper-Manufacture (1870).

Name of Mill.	Description of Paper Manufactured.	Weight of Paper made in the year—pounds.	Proportion of raw fibrous materials used—per cent.	Weight of solid impurities contained in liquid refuse—pounds.
Polton,	Fine writing-paper,	1,120,000	100.00*	309,120
Esk,	Fine writing-paper,	3,315,000	14.20* 85.80†	2,763,700
Springfield,	Printing-paper,	2,464,000	9.25* 90.75†	2,648,300
Dalmore,	Printing-paper,	1,496,000	1.86* 98.14†	1,757,200

* Rags. † Esparto.

DETAILS OF THE NORTH ESK PAPER-MANUFACTURE.

Statement of Materials Actually Used, and Liquid Refuse estimated to result from the Manufacture of 1,000 pounds of Paper, for Various Cases.

NAME OF MILL AND QUALITY OF PAPER MANUFACTURED.	PAPER-STOCK AND ORGANIC REFUSE.			CHEMICALS AND SALINE REFUSE.					
				ALKALIES.		BLEACHING POWDERS.		ALUM AND ACID.	
	Gross Weight of Raw Material consumed—pounds.	Calculated Net Weight deducting, viz.: rag dust, 10 per cent.; water fixed in crude fibres, 10 per cent.—pounds.	Loss from Net Weight during Manufacture. Liquid Refuse—p'ds.	Gross Weight used—pounds.	Calculated Dry Weight of Liquid Refuse—pounds.	Gross Weight used—pounds.	Calculated Dry Weight of Liquid Refuse—pounds.	Gross Weight used—pounds.	Calculated Dry Weight of Liquid Refuse—pounds.
POLTON MILL. Manufacture of fine writing-paper, ...	Rags, . 1,316	Rags, . 1,184	184	Caustic soda. 42.	32.76	Estimated. 64.	32.	Alum. 50.	27.2
ESK MILL. Manufacture of fine printing-paper, ...	Rags, . 237 Esparto, 1,433	Rags, . 213 Esparto, 1,290	503	Soda-ash. 2. Caustic soda. 273.2 Soda-crystals. 25.	2. 185. 9.5	170.3	85.15	Alum. 53 4 Vitriol. 21. Antichlor. 4.	29.1 17.1 2.85
SPRINGFIELD MILL. Manufacture of printing-paper, ...	Rags, . 182 Esparto, 1,782	Rags, . 163.6 Esparto, 1,604	767.6	Soda-ash. .5 Caustic soda. 272.7	.5 212.7	182.	91.	Alum. 5.45	2.97
DALMORE MILL. Manufacture of printing-paper, ...	Rags, . 36 Esparto, 1,883	Rags, . 32.3 Esparto, 1,695	727.3	Caustic soda. 127.2 Soda-crystals. 226. Lime. 161.7	99.2 85.9 110.	242.5	121.2	Alum. 56.9	31.

NOTE.—The lime used for "causticising" soda, and the "waste bleach-lime," are excluded from the liquid refuse. The analyses were made for the Rivers Pollution

Details of the North Esk Paper-Manufacture – Continued.

NAME OF MILL, AND QUALITY OF PAPER MANUFACTURED.	WATER. Total Quantity Consumed in the Manufacture.	COMPOSITION OF THE DRAINAGE WATER. Recapitulation, Calculated Weights of Dissolved, or Suspended Matters, from the Manufacture—pounds.	Same values proportioned to 100,000 parts of the Drainage-Water.	Actual Composition from Analysis, per 100,000 Parts. Organic.	Inorganic.	Total.	
POLTON MILL. Manufacture of fine writing-paper,*	U. S. gallons, . 70.700 Pounds water, . 589.300 Containing lbs. impurities, . 168.75 [28.64 to 100,000.]	Organic, 184.0 Alkaline, 32.8 Bleach, 32.0 Alum, 27.2 276.0	Organic, 31.21 Alkaline, 5.55 Bleach, 5.43 Alum, 4.61 46.80	– 19.285	– 34.285	17.14 53.57 70.71 28.64 42.07	Suspended. Dissolved. Due to the water. Refuse.
ESK MILL. Manufacture of fine printing-paper,†	U. S. gallons, . 56.470 Pounds water, . 470.560 Containing lbs. impurities, . 67.24 [14.29 to 100,000.]	Organic, 503.0 Alkaline, 196.5 Bleach, 85.15 Alum, 49.05 833.70	Organic, 106.69 Alkaline, 41.68 Bleach, 18.06 Alum, 10.40 176.85	– 19.00	– 47.14	21.00 66.14 87.14 14.29 72.85	Suspended. Dissolved. Due to the water. Refuse.
SPRINGFIELD MILL. Manufacture of printing-paper,†	U. S. gallons, . 16.070 Pounds water, . 133.900 Containing lbs. impurities, . 30.55 [22.82 to 100,000.]	Organic, 767.6 Alkaline, 213.2 Bleach, 91.0 Alum, 3.0 1,074.8	Organic, 568.60 Alkaline, 157.92 Bleach, 67.41 Alum, 2.22 796.15	82.04 – 26.67 108.71	51.96 36.10 101.33 189.39	134.00 164.10 298.10 22.82 275.28	Suspended. Chlorine. Dissolved. Due to the water. Refuse.
DALMORE MILL. Manufacture of printing-paper,†	U. S. gallons, . 36.090 Pounds water, . 300.740 Containing lbs. impurities, . 47.2 [15.73 to 100,000.]	Organic, 727.3 Alkaline, 295.1 Bleach, 121.2 Alum, 31.0 1,174.6	Organic, 240.83 Alkaline, 97.72 Bleach, 40.13 Alum, 10.26 388.94	– 43.43	– 82.43	59.14 125.86 185.00 15.73 169.27	Suspended. Dissolved. Due to the water. Refuse.

* The general drainage here is understood to receive of all the liquid refuse.

† The esparto-liquor in this mill is saved, and the soda recovered.

Metal Manufactures.

In comparison with the damage which is inflicted upon river-waters by the sewage of towns and by the drainage from factories devoted to the various branches of industry connected with textile fabrics, the pollution caused by the metal trades, with one or two exceptions, is quite insignificant. This is owing, in the first place, to the circumstance that the greater number of the metal trades are carried on with but very little use of water; and, in the second, to the general absence of organic matters from the waste products arising in the working of metals. The exceptions to this general rule are, notwithstanding, so important, as to deserve careful attention.

The sources of river-pollution brought about by metal-working may be thus classified, viz.:—

1. Pollution by cinders, *scoriæ*, and furnace-ashes.
2. Pollution by acids.
3. Pollution by metallic salts.

The branches of the metal industry which give rise to these forms of river-pollution will be noticed, and some of the specific effects of the noxious refuse shown.

Iron-Works and Rolling-Mills.

The iron-manufacture occupies both in Great Britain and in the United States the leading place among the metal industries. The purely metallurgical operations of smelting, by which the metal is extracted from its ores, are almost necessarily carried on in the immediate vicinity of either the ore, or the coal by which it is to be reduced; the reworking of the metal into articles of general or technical use, is not limited, more than other branches of manufacturing industry, to given localities.

Except for the generation and condensation of steam, water is only incidentally used in iron-works and rolling-mills; chiefly for the purpose of cooling the rolls. The bearings of these rolls are lubricated with tar or coarse grease, some of which is washed away by water along with scales of oxide

from the iron. The amount of pollution thus caused to neighboring streams by works of moderate size is insignificant, as will be seen from the statement of the composition of drainage-water issuing from the Dowlais Iron Works, situated near Merthyr Tydfil in Wales, where 2,000 tons of coal were at the time burnt daily, and about 2,000 tons of iron, beside 700 tons of steel, were manufactured weekly.

Analyses of Water polluted by Iron-Works and Rolling-Mills. Impurities present in 100,000 Parts.

DESCRIPTION.	Dissolved Matter.					Suspended Matter.		
	Total Dissolved Matter.	Organic Carbon.	Organic Nitrogen.	Chlorine.	Metallic Arsenic.	Mineral.	Organic.	Total.
General drainage from Dowlais Iron Works,* . . .	50.80	.233	.144	1.60	–	4.42	2.30	6.72
Morlais Brook, below Dowlais Iron Works,† . . .	83.74	.104	.029	2.65	.048	8.38	6.40	14.78

* June 20, 1871. † June 19, 1871.

The consumption of coal at the Dowlais Iron Works is to the net metallic product of the works as 4½ to 1, weight for weight. The following table will show the general composition of the Welsh coal, and at the same time afford a comparison with other more generally known varieties of coal.

Composition of various kinds of Coal.

CONSTITUENTS.	Cannel Coal.	Bituminous Coal.	Welsh or Smokeless Coal.	Anthracite Coal.
Carbon, ...	79.23	82.64	88.66	94.18
Hydrogen, ...	6.08	5.31	4.63	2.99
Oxygen, ...	7.24	5.69	1.03	.76
Nitrogen, ...	1.18	1.35	1.43	.50
Sulphur, ...	1.43	1.24	.33	.59
Ash (mineral matter), .	4.84	3.77	3.92	.98
Total, ...	100.00	100.00	100.00	100.00

The sulphur, which the foregoing analysis shows to be a constituent of coal, is present chiefly in the form of pyrites, which is a compound of sulphur, iron, and a variable but usually small proportion of arsenic.

Of all descriptions of metal-working, the production of iron and steel occasions the largest consumption of coal and presents the most important examples of pollution by cinder-refuse, Works for converting these materials to special uses, —nail-works, foundries, and others of the like class—though conducted upon a smaller scale, are likewise liberal consumers of coal; the ashes and slag from which accummulate upon the premises, even if they do not actually encroach upon the channel of the stream which receives their drainage.

Iron and Steel Wire, and Galvanizing Works.

The metalliferous liquors discharged from works coming under this classification, together with those sometimes allowed to escape in much smaller quantities from brass-foundries, German-silver works, and electro-plate factories, contain metallic salts, which, in all well-regulated works, should be manufactured into marketable products and, sold or disposed of in their crude condition to chemical manufacturers, to be utilized by them.

Of all the forms of river-pollution arising from industries connected with the working of metals which will come under notice, that produced by the waste liquors discharged from wire and galvanizing works is the most intense and noxious. In these operations, iron, in the form of wire or sheet, of nails, and numerous articles of special use, is the metal subjected to treatment.

The process of galvanizing or zincing iron, is thus described:—

Sheet-iron, iron-castings, and various other objects in iron are cleaned and scoured by immersion in a bath of water acidulated with sulphuric acid, heated in a leaden vessel, or used cold in one of wood, in order to remove the oxide. They are then thrown into cold water, and taken out, one at a time, to be scoured with sand and water, with a piece of cork, or more usually with a piece of the husk of the cocoa-nut, the ends of

the fibers of which serve as a brush, and the plates are afterwards thrown into cold water.

Pure zinc, covered with a thick layer of sal-ammoniac to prevent the loss of the metal by oxidation, is then melted in a bath, and the iron, if in sheets, is dipped, several sheets at a time, in a cradle or grating. The sheets are slowly raised to allow the superfluous zinc to drain off, and are thrown whilst hot into cold water, on removal from which they require to be wiped dry.

Thick pieces are heated before immersion, in a reverberatory furnace, to avoid cooling the zinc. Nails and small articles are dipped in acid, and dried in a reverberatory furnace, and thrown together into the zinc, left for one minute, and then taken out slowly with an iron skimmer; they come out in a mass soldered together, and are separated by being reheated in charcoal-powder and shaken about until cold. Wire is reeled through the zinc, into which it is compelled to dip by a fork or other contrivance.

In the operation of steeping, or "pickling," as it is technically termed, iron is subjected to the action of dilute sulphuric or muriatic acid for the purpose of dissolving oxide from the surface of the metal; and as the solution must possess considerable strength to effect this, there is always left in the bath, when it is practically exhausted, a large proportion of free acid. There is also in solution a larger proportion of sulphate or muriate of iron: the first a product of some value, and easily disposed of; the second a compound of considerable repute as a disinfectant, but for which there is only a variable and uncertain market. Muriatic acid seems to be selected in England chiefly because of its superior cheapness in some localities; in the United States, so far as known, sulphuric acid is employed almost exclusively in the processes referred to. It is understood, however, to be the general practice in these works to discharge the waste contents of the acid-baths suddenly into rivers or sewers, as the case may be, rendering the water of the former unfit for the support of fish-life, if not absolutely injurious to the health of man or air-breathing animals, and, by the corrosive action of the free acid, dissolving the cement and loosening the brickwork of the latter.

Wire-works, for the manufacture of iron and steel wire, consume considerable quantities of acid in the "drawing" process. The metal requires to be annealed from time to time, between successive drawings, otherwise it would become too hard and brittle for further extension; to loosen and remove the crust of oxide which forms during the annealing, the coil of wire is "pickled" in dilute sulphuric acid, followed usually by immersion in milk of lime.

Iron-foundries engaged in the manufacture of plows and similar work, also use acid for the loosening and removal from the surface of the castings of a silicious crust or scale which adheres to them from the sand of "unfaced" molds in which the castings have been formed.

Shovel-works, as a distinct branch of the iron and steel industry, consume acid largely, and under the same general conditions as wire-works.

The waste liquors from these various works may be considered as identical in character with those from galvanizing works, already described, containing free sulphuric acid and copperas (sulphate of iron) as their chief ingredients. The chemical composition of the waste liquors from certain wire and galvanizing works is given in the following table :—

Analysis of Waste Liquors from Iron Wire and Galvanizing Works.

[Impurities present in 100,000 parts.]

FIRM, ETC.	DESCRIPTION.	Dissolved Matters.					Suspended Matters.		
		Total Dissolved Matters.	Metallic Iron.	Chlorine.	Sulphuric Acid.	Acidity, equivalent in parts of Muriatic Acid.	Mineral.	Organic.	Total Suspended Matters.
	Wire and Galvanizing Works.								
Byland Bros., Warrington, Eng., .	General drainage of works, .	7,727.	598.69	230.	127.38	601.6	109.	1,431.	1,540.
	Washing and pickling vats, .	2,309.	None.	120.	495.11	None.	172.05	268.5	1,989.
	Galvanizing-Works.								
Kings & Newton, Birmingham, Eng., .	Pickling liquor sent to waste (diluted with six parts of water), ...	38,020.	15,023.7	19,750.	447.08	25,192.	Very	turbid.	
	Iron-Wire Works.								
Dartmouth Wire W'ks, England, . . .	Pickling liquor, ...	23,945.	7,670.	72.	11,706.8	10,114.4	Very	turbid.	
	Drainage of the works, . .	1,009.	218.68	44.	383.18	None.	132.52	35.56	168.08

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These numbers prove in the most unmistakable manner the strongly acid character of most of these waste liquors; and the injury done by them is greatly intensified if they are suddenly discharged in large volume into either sewers or streams. This nuisance is disposed of in the following manner at a tin-plate works:—

The sheet-iron, previous to receiving its coating of tin, is pickled repeatedly in dilute sulphuric acid, but the waste liquor, instead of being discharged as formerly into the neighboring stream, is concentrated in shallow leaden evaporating-pans, until, on cooling, it deposits a copious crop of crystals of green copperas, which is sold at a small profit; the mother-liquor from these crystals is fortified with fresh sulphuric acid, and used over again, none being allowed to go into the river.

Brass-Foundries and Electro-plate Works.

In the actual founding of brass, water is not used, but in the subsequent treatment of the copper-zinc alloy, there are operations in which acid liquors are employed. Such liquids, when exhausted, consist of salts of copper and zinc dissolved in acid water; they are at least as injurious to sewers and running waters as the waste liquors from galvanizing-works; but being produced in very much smaller quantity, and possessing, bulk for bulk, a much higher value, on account of the copper which they contain, the recovery of the metal is frequently effected, and thus pollution from brass-foundries is comparatively insignificant.

In works for the manufacture of brass and copper tubing, a pickling liquor of dilute sulphuric acid is used to remove the scaly deposits formed upon the surface of the metal in the operation of soldering. A means of recovering the copper from the solution, consists in placing scrap-iron in the exhausted liquor, which replaces the first metal in the chemical combination; the altered liquor, it is to be feared, is then sent to waste. The analysis of a sample of this liquor will be found in the subjoined table.

Composition of Waste Liquors from Brass-Foundries.

[Impurities present in 100,000 parts.]

DESCRIPTION.	Dissolved Matters.							Suspended Matters.
	Total Dissolved Matters.	Metallic.			Chlorine.	Sulphuric Acid.	Acidity, equivalent in parts of Muriatic Acid.	
		Iron.	Copper.	Zinc.				
Brass-Foundries.								
General drainage,	55.7	–	–	–	8.5	13.6	–	15.20
Waste nitric-acid liquor,	8,224.4	–	537.1	379.	42.	–	5,865.6	*
Washing-water liquor,	1,216.	3.64	82.4	39.16	–	–	684.3	†
Brass-Tube and Wire Works.								
Waste-acid liquor containing sulphate of iron in solution,	32,161.	7,285.9	15.96	1,280.6	65.	17,474.	15,792.	*

* Very turbid. † Slightly turbid.

In the manufacture of chandeliers, brass is first pickled in dilute nitric acid and then immersed in a dilute solution of nitrate of iron, or of arsenious acid, for the purpose of imparting a copper color, or "bronzing," to the brass, which, after polishing with a kind of red chalk, is browned by being heated in a muffle. The composition of the water in which the brass articles are washed after being removed from the pickling liquor, is also given (see preceding page).

The process of electro-plating is chiefly employed in an industrial sense, in those cases where it is desired to coat an inferior metal or alloy with a film of silver, gold, or nickel, either as a protection from corrosion, or for ornament, or for both purposes.

The metal to be applied is in all cases held in the form of a solution in a bath, in which are also placed the articles to be plated. The dissolved metal is then thrown down by the action of electricity or galvanism upon the surfaces previously prepared for its reception. No waste or pollution of water attends the plating process itself, though in the fabrication of plated ware noxious waste liquors are produced.

In the preparation of the articles intended to receive plating, they are steeped for a short time, sometimes in dilute nitric acid, and sometimes in dilute sulphuric acid, and then polished on a wheel by fine sand, followed by rouge; in other cases a boiling in potash-lye precedes the pickling in acid.

A statement of the composition of the alloys employed by the manufacturers of plated work will explain the character of the metallic salts present in the exhausted pickling liquors. The component metals of the two most extensively used alloys are here given.

Composition of the Alloys.

German (or Nickel) Silver.		Britannia-Metal.	
Copper, . . .	57 parts.	Copper, ...	17 parts.
Zinc, ...	19 "	Zinc, ...	8 "
Nickel, ...	24 "	Tin, ...	25 "
		Antimony, . . .	25 "
Total, . . .	100	Bismuth, . . .	25 "
		Total, . . .	100

Of these alloys, that known as britannia-metal is believed to be more largely used in the United States, and German-silver and copper in England, for silver-plated manufacture.

After undergoing the plating operation, the articles are partly burnished and partly polished, a mixture of powdered quicklime and oil answering for this purpose.

Neither of these processes requires the use of water.

Poisoned Water — Its Limits.

A great many chemical compounds, some derived from inorganic matters, and others formed in animals or plants, produce peculiar changes in the living animal organisms. They destroy the vital function of individual organs; and, when their action attains to a certain degree of intensity, death is the consequence. The action of inorganic compounds, such as acids, alkalies, metallic oxides, and salts, can, in most cases, be easily explained: they either destroy the continuity of particular organs, or they enter into combination with their substance. The latter is characteristic of true inorganic poisons, a class which includes the principal metallic oxides and salts; such substances as sulphuric, muriatic, and oxalic acids, and hydrate of potash, though violently injurious, or fatal under certain conditions, not being strictly poisons. True inorganic poisons are such through their power of forming permanent compounds with the organic substance of membrane and muscular fiber, in the exercise of a chemical affinity more powerful than the vitality of the organ on which they act.

The effect upon fish of a number of leading and potent polluting substances occurring as manufacturing refuse was subjected to actual test for each substance separately, and for different degrees of intensity, in an elaborate series of experiments carried out in Glasgow, Scotland, in the year 1867, by Messrs. Penny and Adams. The information which was so obtained may be considered invaluable, as affording precise and cogent evidence of the degree of dilution at which the noxious matters prove speedily fatal, and the degree at which they are, so far as observation goes, harmless. Moreover, it

is not known, that apart from these experiments, any records of special investigation into the physiological effects upon fish-life of the class of substances referred to have been anywhere made.

The following facts touching the class of refuse arising from metal-working are selected from the report of the experiments, and fully confirm, it is believed, the results and deductions of previous chemical researches. For purposes of comparison, the action of certain substances not connected with the metal industry are also noticed.

The series of experiments to which reference is had were conducted upon goldfish and minnows as subjects. These two kinds of fish possess different temperaments, the minnow being remarkable for its delicate vitality, and for the fine sen sibility it evinces toward all kinds of disturbing influences, the goldfish on the other hand possessing a comparative tenacity of life, and a sluggishness of nature that permits sufficient length of time for observing the action of poisonous agents.

Experiments with Acids.

Of the mineral acids, the nitric and sulphuric were the most powerful, killing fish when present in the proportion of one part to fifty thousand, while, in the same proportion, muriatic acid did not destroy life. Arsenious acid, the well-known poison of arsenic, proved, as was expected, a very deleterious agent: a minnow died in water contaminated with one thirty-five thousandth part, and although the hardy goldfish survived when exposed for twenty hours to a like proportion, there was sufficient evidence that its power of endurance had been fully tested.

Carbolic acid, one of the most active principles of coal-tar, was found peculiarly destructive, its tendency being to kill, like certain of the nervine poisons, by the first shock.

Certain of the vegetable acids exhibited great potency, tannic acid particularly; a minnow was killed by one fourteen thousandth part of this, and a goldfish by one seven thousandth part.

Experiments with Metallic Salts.

Of the metallic salts, by far the most virulent in its properties was the sulphate of copper; a strong fish was killed in water which contained only a proportion of one to one hundred thousand. Sugar of lead, alum, the salts of iron and tin, are all destructive of fish-life, and the proportion in which they prove fatal, about one to four thousand, is nearly alike in all.

The effects of chloride of lime were studied with special interest; it was found that a proportion of one part of a saturated solution of this substance to twenty-one thousand parts of water, was the nearest in which a fish ultimately survived, after having been exposed for some hours to its action. This salt is a powerful irritant, and its local effects are very evident. The fish exposed to its influence soon becomes covered with an exudation of grayish matter, the scales and fins lose their transparency, while mucus and even blood exude from the gills. An almost instantaneous injury results from exposure to a strong solution of it, the fish rarely escaping death.

Experiments with Special Chemicals.

In the group thus named there will be found in each substance a poisonous agency of great power. They are all strongly irritant, and evidently kill by producing a local injury, probably of a corrosive character.

The nearest limit in which a fish lived when exposed in a saturated solution of chlorine, was a proportion of one to two thousand.

Iodine killed with a seventy thousandth part, and bromine was destructive only in a lesser degree.

Caustic potash destroyed a fish when present in a thirty thousandth part.

Experiments with Furnace-Ashes.

Coke, as used in foundries, and also ordinary furnace-cinders, or ashes, were found to constitute a source of danger not previously suspected. Whether discharged in heaps at the banks,

or thrown into the channel of the stream, or furnishing their hurtful influence to the waters through the drainage of rain-washings, they are believed to be the means of inflicting an injury upon fish-life, for which other agencies, perhaps altogether blameless, may be called to bear the responsibility.

The important bearing of this suggestion will be best illustrated by the simple reference to the fact, that in two experiments made with five hundred grains of furnace-ashes to a gallon of water (one one hundred and fortieth part) a minnow died in forty-three minutes, and a vigorous goldfish in five and a half hours.

Results of Experiments on Fish, restated.

Noxious Substances added to Water.		Limit at which the Substance proved fatal. Proportionate part.
Acids,	Sulphuric,	$\frac{1}{50000}$
	Nitric,	$\frac{1}{50000}$
	Muriatic,	—
	Arsenious, (common arsenic),	$\frac{1}{35000}$
Metallic salts,	Sulphate of copper,	$\frac{1}{100000}$
	Sulphate of iron,	$\frac{1}{10000}$
	Sulphate of alum,	$\frac{1}{10000}$
	Acetate of lead,	$\frac{1}{4000}$
	Chloride of lime, saturated solution,	$\frac{1}{16000}$
Special chemicals,	Chlorine, saturated solution,	$\frac{1}{1400}$
	Iodine,	$\frac{1}{70000}$
	Bromine,	$\frac{1}{85000}$
	Caustic potash,	$\frac{1}{30000}$
Coal-products,	Foundry-coke,	$\frac{1}{150}$
	Furnace-cinders,	$\frac{1}{140}$
	Coal-tar,	$\frac{1}{8750}$

Examination of River-Basins.

The positions and character of the mills and factories on the rivers examined this season, will now be given, beginning with the "Blackstone."

The following list condenses the information obtained by Mr. E. K. Clark, the assistant engineer; the quantities of materials used at the different factories are given where they could be obtained.

Blackstone River.

Comparing this river, which is probably more polluted than any other in Massachusetts, with the English rivers given in the general table, it will be seen that the population of the valley is greater per square mile than that of the Thames valley above Hampton; and that the number of mills and factories referred also to the same measure is three times greater. The converse would be true, however, if we used for comparison some of the rivers of the manufacturing districts in England, as the Mersey and others.

By means of the index letters and names, the reader will be able to trace the list upon the map.

Mills, Factories, etc., in the Blackstone River Valley.

Name of Stream or River.	Letters corresponding with Letters on Map.	DESCRIPTION OF MILL.	Location.	No. of Hands Employed.	No. of Spindles.	Head and Fall.	Sets of Machinery.	Quantities of Material used per year, so far as known.
						Ft. In.		
Blackstone River, .	A	Dellebar & Mason, Woolen Mill.	Blackstone, .	210	-	11	12	168 tons logwood, 182 bbls. oil, 20 bbls. urine, small amount ammonia.
	b	Evans, Legrave & Co., Woolen Mill.	Blackstone, .	200	-	11	-	40 tons logwood, 3,000 lbs. madder, 75 bbls. oil, 15 bbls. urine, 6,000 lbs. copperas.
		Blackstone Cotton M'f'g Co., .	Blackstone, .	1,000	52,000	36	-	
	a d	Hanson, Bliss & Co., Woolen Mill.*	Millville, . .	65	-	15	-	20,000 lbs. wool, 12 bbls. oil.
		Wilcox & Aldrich, Flock Mill,*	Millville, . .	20	-	12	-	
		Fred. Thayer, Shoddy Mill,* .	Millville, . .	4	-	12	-	
	z	Uxbridge Woolen Mill, . .	Uxbridge, . .	170	-	8 5	12	30 tons logwood, 9½ tons soda-ash, a little oil of vitriol, ammonia and madder.
	j	Central Woolen Mill, . .	Uxbridge, . .	150	-	12	10	30 tons logwood, 9 tons soda-ash, 75 bbls. oil, 1 ton madder.
		Paul Whitting & Co., Cotton M'f'g., "Riverdale Mills,"	Northbridge, .	98	6,456	11 6	-	22,880 lbs. cotton.
		Rockdale Mills, Cotton, . .	Northbridge, .	140	10,568	12	-	405,000 lbs. cotton.
	k B	Farnumsville Cotton Mill, .	Grafton, . .	70	5,952	7	-	286,000 lbs. cotton.
		Fisherville Cotton Mill, . .	Grafton, . .	112	5,500	10	-	444,600 lbs. cotton.
		Saundersville Cotton Mill, .	Grafton, . .	130	12,000	11	-	372,800 lbs. cotton.

Blackstone River, .	n	Privilege belonging to Sutton & Co.	Sutton, . .	-	-	12		-	
		Simpson Woolen M'f'g Co., .	Millbury, . .	80	-	10		-	600,000 lbs. material (cotton and wool).
		Cordis Cotton Mill, . . .	Millbury, . .	110	6,176	14		-	450,000 lbs. cotton.
		Millbury Cotton Mill, . .	Millbury, . .	75	7,000	13		-	327,600 lbs. cotton.
	o	Atlanta Woolen Mills, . .	Millbury, . .	113*	-	10	6	-	180,000 lbs. wool, 25 tons logwood, 14,400 lbs. soda-ash, 25 bbls. oil, 1,000 lbs. copperas, 9,000 lbs. blue vitriol.
	p	Morse Sash and Blind M'f'y,* .	Millbury, . .	15	-	7		-	
		Machine-shop,* . . .	Millbury, . .	15	-	7		-	
		Burling Woolen Mill, . .	Millbury, . .	130	-	12		8	30,000 lbs. wool, 36 tons logwood, 18 tons soda-ash.
		Whipple & Co., Grist Mill, .	Worcester, . .	2	-	8		-	Three run of stones.
		Bone-boiling establishment on opp. side of river; do not use power.	Worcester, . .	5	-	-		-	Large amount of refuse goes into the river from this establishment.
	r s	Quinsigamond Iron Works, .	Worcester, . .	500	-	15		-	
Kettle Brook, . .	y	Rice & Thayer, Cotton Warp and Yarn.	Worcester, . .	45	-	4	1	-	
		Crompton Carpet Co.,† . .	Worcester, . .	75	-	4	6	-	
		Packachoag Mills, Cotton,† .	Worcester, . .	75	-	-		-	
		Hopeville Woolen Mill, . .	Worcester, . .	25	-	6	6	3	25,000 lbs. rag-shoddy.
		Curtis Woolen Mill,‡ . .	So. Worcester, .	150	-	14		5	480,000 lbs. woolen material.
		Curtis Machine-shop,‡ . .	So. Worcester, .	40	-	14		-	270,000 lbs. woolen material.
		Trowbridge Woolen Mill, .	So. Worcester, .	40	-	11	6	3	327,600 lbs. cotton.

* At one dam. † At same dam. ‡ At one dam.

Mills, Factories, etc., in the Blackstone River Valley—Continued.

NAME OF RIVER OR STREAM.	Letters corresponding with Letters on Map.	DESCRIPTION OF MILL.	Location.	No. of Hands Employed.	No. of Spindles.	Head and Fall.	Sets of Machinery.	Quantities of Material used per year, so far as known.
						Ft. In.		
Kettle Brook, . .		Stoneville Cotton Mill,† . .	Auburn, . .	75	-	24	-	
		Tape Manufacturing,† . .	Auburn, . .	50	-	24	-	
		Jamesville Woolen Mill, . .	Worcester, . .	90	-	23	-	
		Hunt's Woolen Mill, . .	Worcester, . .	30	-	17 3	-	120,000 lbs. woolen material, small quantity soda-ash, logwood, oxalic acid.
		Darling's Woolen Mill, . .	Worcester, . .	23	-	14 7	2	120,000 woolen material.
		Ashworth & Jones, Woolen Mill,	Worcester, . .	80	-	35 6	4	240,000 lbs. woolen material.
		Wright Bottomly Shoddy Mill,	Leicester, . .	30	-	10 8	-	12,000 lbs. soda-ash.
		Smith Woolen Mill, .	Leicester, . .	100	-	20	4	150,000 lbs. wool, 18,000 lbs. soda-ash.
		Geo. W. Olney, Woolen Mill, .	Leicester, . .	60	-	26	6	132,000 lbs. wool, 5,750 lbs. soda-ash, 70 bbls. soap.
		Unoccupied privilege, . .	Leicester, . .	-	-	10	-	
		Dickinson's Woolen Mill, .	Leicester, . .	9	-	9 4	1	The two mills belong to one party, and use 210,000 lbs. woolen material.
		Chapel Woolen Mill, . .	Leicester, . .	23	-	14 6	2	
	u	Booth Bottomly Woolen Mill, E. D. Thayer.	Leicester, . .	90	-	21 3	4	210,000 lbs. woolen material, 15,000 lbs.

Kettle Brook, . .		Kent's Shoddy Mill, . .	Leicester, . .	8	-	7	8	-	
		Mann & Marshall, Woolen Mill,	Leicester, . .	22	-	20		-	150,000 lbs. woolen material, 1,800 lbs. soda-ash, 5 bbls. soap.
Ramshorn Brook, .		Dunn's Shoddy Mill, . .	Millbury, . .	3	-	11		-	
		Leonard's Woolen Mill, . .	Auburn, . .	56	-	14		-	270,000 lbs. woolen material, 15,000 lbs. soap.
		Wood's Cotton M l, . .	W. Millbury, .	40	-	25		-	
Dark Brook, . .		Grist Mill, ...	W. Millbury, .	-	-	11		-	One stone.
Singletary Brook, .		John Rhodes, Cotton Mill, .	Millbury, . .	30	2,000	22		-	167,000 lbs. cotton.
		Crane & Waters, Stocking Factory.	Millbury, . .	125	-	20		10	15,000 lbs. cotton, 20,000 lbs. wool.
		Walling Woolen Mill, . .	Millbury, . .	120	-	23	6	7	300,000 lbs. wool, 24 tons logwood, 10,800 lbs. soda-ash, 1,000 lbs. copperas.
		Bramanville Cotton Mill, . .	Millbury, . .	55	-	22		-	150,000 lbs. cotton.
		Eagle Woolen Mill, ...	Millbury, . .	120	-	23		-	300,000 lbs. wool, 24 tons logwood, 24,000 lbs. soap.
	t	Crane & Waters, Cotton Mill, .	Millbury, . .	53	3,768	20		-	140,400 lbs. cotton.
		Wheeler Cotton Mill, . .	Millbury, . .	55	-	25		-	280,800 lbs. cotton.
Tatnick Brook, . .	d''	A. G. Coes, Iron Wrench M'f'g,*	Worcester, . .	50	-	13	6	-	Small quantity of acid used in pickling.
		Row & Culver, Iron Pat. Shears,*	Worcester, . .	4	-		-	-	
		John Dean & Co., M'f'g daguerreotype goods.*	Worcester, . .	3	-		-	-	
		Loring Coes, Machine-shop, .	Worcester, . .	40	-	14	6	-	24 carboys of acid in pickling iron-work.
		Loring Coes, Edge Tools, .	Worcester, . .	9	-	15		-	
		W. C. Smith, Wood-work, .	Worcester, . .	10	-	8		-	

* At one dam.

† At same dam.

Mills, Factories, etc., in the Blackstone River Valley—Continued.

Name of River or Stream.	Letters corresponding with Letters on Map.	Description of Mill.	Location.	No. of Hands Employed.	No. of Spindles.	Head and Fall. Ft.	Head and Fall. In.	Sets of Machinery.	Quantities of Material used per year, so far as known.
Tatnick Brook, .		W. W. Patch, Grist Mill, . .	Worcester, . .	2	-	19		-	Three stones.
		Reservoir Dam, ...	Worcester, . .	-	-	17		-	
		Satinet Mill, H. F. Butler, .	Worcester, . .	13	-	12	6	-	120,000 lbs. woolen stock.
		A. L. Whiting, File Manuf'g, .	Worcester, . .	11	-	13		-	
		Pond's Reservoir Dam, . .	Worcester, . .	-	-	16		-	
		St. George's Blanket Factory, .	Worcester, . .	6	-	16	6	-	60,000 lbs. stock.
		Shoddy Mill, ...	Worcester, . .	2	-	11		-	
Mill Brook, . .	X	Wire Manuf'g, ...	Worcester, . .	500	-	18		-	
	V	Warren's Tannery, ...	Worcester, . .	6	-	6	6	-	Tan 1,800 hides.
		Buttrick's Yarn Factory, Cotton,	Worcester, . .	10	-	8		-	
		Daniels & Son, Cotton Mill, .	Worcester, . .	20	1,440	16		-	75,000 lbs. cotton.
Dorothea Brook, .		Chamberlain's Wool Washing Establishment.	Millbury, . .	30	-	8		-	Cleanse 120,000 lbs. wool; use 31,200 lbs. soda-ash, 150 bushels salt.
		Grist Mill, ...	Millbury, . .	1	-	12		-	
		Machine-shop, ...	Millbury, . .	5	-	14		-	

Quinsigamond River,	m	Quaker Cotton Mill, . . .	Grafton, . .	80	3,500	12		-	180,000 lbs. cotton.
		Grist Mill, ...	N. England Vill.,	-	-	16		-	
		Grafton Cotton Mills,* . .	N. England Vill.,	250	12,000	15		-	
		Grafton Cotton Mills, . .	N. England Vill.,	-	-	5	6	-	
		Grafton Cotton Mills, . .	N. England Vill.,	-	-	17		-	
Cold Spring Brook, .	d	Shuttle Manuf'g, . . .	Sutton, . .	18	-	15		-	
		Grist Mill, ...	Sutton, . .	1	-	19		-	
		Woolen Mill,†	Sutton, . .	35	-	19		2	156,000 lbs. woolen material.
W. Branch Brook, .		Box Factory, ...	Sutton, . .	2	-	41	2	-	
		Shuttle Man'f'g, . . .	Sutton, . .	-	-	15		-	
E. Branch Brook, .		Flock Mill, ...	Sutton, . .	3	-	25		-	
		Unoccupied privilege, . .	Sutton, . .	-	-	20		-	
		Flock Mill, ...	Sutton, . .	3	-	32		-	
Mumford River, .		Capron Woolen Mill,‡ . .	Uxbridge, . .	80	-	12		5	50,000 lbs. wool, 7,000 lbs. logwood, 2,500 lbs. soda-ash.
		Shoddy Mill,‡	Uxbridge, . .	12	-	-		-	
		Uxbridge Cotton Mill, . .	Uxbridge, . .	140	10,192	14	6	-	
		Linwood Cotton Mill, . .	Uxbridge, . .	200	15,000	13	8	-	624,000 lbs. cotton.
		Whitinsville Cotton Mill, .	Northbridge, .	200	12,336	17		-	600,000 lbs. cotton.

* Upon three privileges. † A short distance above this mill, the brook divides. ‡ At same dam.

Mills, Factories, etc., in the Blackstone River Valley—Continued.

Name of Stream or River.	Letters corresponding with Letters on Map.	Description of Mill.	Location.	No. of Hands Employed.	No. of Spindles.	Head and Fall.	Sets of Machinery.	Quantities of Material used per year, so far as known.
						Ft. In.		
Mumford River,		Whiting Machine Co.,	Northbridge,	450	-	18	-	350 lbs. vitriol per day for pickling castings.
		Douglas Axe Man'f'g,	Douglas,	-	-	12	-	
		Douglas Axe Man'f'g,	Douglas,	-	-	18	-	
		Shoddy Mill,	Douglas,	4	-	13	-	
		Douglas Axe Man'f'g,	Douglas,	-	-	11	-	
		Douglas Axe Man'f'g,	Douglas,	300	-	12	-	
		Manchang Cotton Mills,	Sutton,	-	-	21	-	
		Manchang Cotton Mills,	Sutton,	-	-	24	-	
		Manchang Cotton Mills,	Sutton,	620	46,000	32	-	1,800,000 lbs. cotton.
Rivulette Brook,		Rivulette Cotton Mill,	Uxbridge,	50	-	14	-	
West River,		Scott's Woolen Mill,	Uxbridge,	30	-	8 6	2	Two tons logwood, 12,000 lbs. soda-ash, 500 lbs. soap, 500 lbs. blue vitriol.
		Wheelock's Woolen Mill,	Uxbridge,	80	-	10	5	30 tons logwood, 12,000 lbs. soda-ash, 1,500 gal. oil, 60 lbs. soap.
Mill River,		Gatchel's Yarn Factory,	East Blackstone,	16	-	7	-	124,800 lbs. cotton.
Quick Stream,		Yarn Factory,	East Blackstone,	13	-	33	-	100,000 lbs. cotton.

Mill River, . .		Box Factory, ...	East Blackstone,	5	-	8	-	
Muddy Brook, . .		Flock Mill, ...	East Blackstone,	3	-	9	-	
Mill River, . .		Hopedale Machine Co., . .	Hopedale, . .	150	-	9	-	
		Dutcher, Temple & Co., Machine-shop.	Hopedale, . .	75	-	13	-	
		Woolen Mills using Steam power.						
		Worcester Felt Co., . . .	Worcester, . .	35	-	-	-	Use $500 or $600 worth of dyestuffs per month, 270,000 lbs. material.
		Worcester Woolen Co., . .	Worcester, . .	200	-	12	-	300,000 lbs. woolen material.
		Adriatic Woolen Mills, . .	Worcester, . .	230	-	14	-	600,000 lbs. woolen material.

Summary for Blackstone River.

	Number.	Operatives Employed.
Woolen Mills,	44	3,003
Cotton Mills,	27	3,978
Iron Works,	12	1,224
Tanneries,	1	6
Shambles,	1	5
	85	8,216

NOTE.—Saw and Grist Mills are not considered polluting.

ANALYSIS OF STATISTICS.

The following table will explain itself. The examples there given, if compared with the analyses of the water taken from the same points, may enable the reader to understand under what circumstances that analysis exposes the previous contaminations received up stream.

BLACKSTONE RIVER.—*This table is intended to explain the rate of dry-weather flow of the stream and the amount of its previous exposure at a few of the points whence water was taken for analyses. The points are indicated by the same letters on the map, and also on the tables of analyses.*

SEE THE POSITIONS OF THE SAME LETTERS ON THE MAP,	A	B	e	i	h	p
Drainage-area above the point indicated by each letter in square miles,	276	138	252.7	57.7	33.5	75.3
Dry-weather flow at respective points in 24 hours, cubic feet,	5,961,600	2,980,800	5,458,320	1,246,320	723,600	1,626,480
Dry-weather flow at respective points in U. S. gallons,	44,592,768	22,296,384	40,828,233	9,322,473	5,412,528	12,164,070
Number of polluting factories or mills,	85	62	79	10	1	41
Number of polluting factories or mills per square mile,	0.3	0.44	0.31	0.173	0.03	0.5
Number of operatives in said mills,	8,216	4,023	6,717	2,056	80	2,319
Population above respective points, 1875,	80,638	61,294	75,598	7,148	5,704	49,465
Population above respective points per square mile,	292.1	444.1	299.1	123.8	170.2	656.9
Population above respective points, 1870,	71,248	54,080	65,527	6,319	4,525	41,305
Population of cities, villages, or mills now sewering into river above said points,	55,050	50,900	54,550	2,700	400	48,500
Population of this character per square mile,	199	369	216	46	12	644

Samples of water were taken from twenty-seven different points. They were sent to Prof. W. Ripley Nichols for examination. The analysis of these waters will be found, as tabulated by him, at the end of this statement.

It may be more profitable here to call the reader's attention to a few of these, than to present the whole in this place.

The following extract (see Table, p. 85), therefore, gives only the head waters not exposed to any pollution, the water from that part of the river where the pollution is most concentrated, and the water from the lowest point of the river at Blackstone.

The water of Mill Brook, after it has received the sewage of Worcester, is shown to be very impure in this table, and on the Blackstone River, at the sash factory, about five miles lower down, it still gives unmistakable signs of the influence of this pollution; but at Blackstone, twenty-five miles below Mill Brook, the dilution produced by numerous small streams delivering into the main river between these points has all but obliterated the evidence of impurity, so far as analyses can expose it; the only marked difference here in the table between the water at Blackstone and the head water of the river, being in the amount of chloiine, the increase, however, of this evidence of impurity not being so great as to condemn the water (by this test) for domestic or any other use. It is to be noted, however, that the river at this time was not at its very low dry-weather stage, which usually occurs in October or November, when it occurs at all. In extreme low water, the river would give greater tokens of impurity.

Of the samples of water received by Prof. Nichols, which were taken from all parts of the Blackstone Valley, he says:—

"The waters were all alkaline; as a rule, they were not so strongly colored as those from the Chicopee, Taunton, etc. The samples taken from the upper parts of the river showed evidence of considerable sewage-contamination. Some of them contained a marked amount of suspended matter, which amount was determined in a few cases. A disagreeable odor was also perceptible in some of the specimens."

Analysis of the Waters of the Blackstone River Valley.

[Parts per 100,000.]

Date.	Letters on Map.	LOCALITY.	Ammonia.	"Albuminoid Ammonia."	Solid Residue. Organic.	Solid Residue. Total.	Chlorine.	Oxygen required.
Sept. 10, 1875,	C″	North Pond above pollution,	.0107	.0213	1.80	4.20	.18	0.588
Sept. 11, 1875,	d′	Lake Quinsigamond—middle,	.0037	.0157	1.56	3.84	0.14	0.304
Sept. 14, 1875,	d‴	City Reservoir—gate-house,	.0072	.0235	1.96	3.76	0.12	0.500
July 29, 1875,		Mill Brook near Blackstone River,	.9600	.1109	4.96	23.44	3.80	1.098
	p	Blackstone River, sash factory,	.0992	.0307	3.20	8.04	0.92	0.429
July 10, 1875,		Blackstone River below Blackstone Mills,	.0099	.0139	1.64	4.80	0.38	-
July 10, 1875,	A	Blackstone River below dam at Blackstone,	.0157	.0163	1.40	4.60	0.36	-

The following additional notes by Mr. E. K. Clark, assistant engineer, who collected the statistics of the Blackstone River Valley, throw some further light on the present condition of its waters:—

"*Blackstone Village* (population, 4,640). The sewage of Blackstone does not flow directly into the river, nearly all the houses being connected with cesspools. From the mills, and a few of the houses along the banks of the river, refuse is discharged directly into the water. The water was quite high in the spring of 1867."

"*Uxbridge* (population 3,026) has no system of sewerage. A part of the houses of the town, with the mills, send the sewage directly into the water. The land is favorably situated for a large amount of surface-drainage reaching the river."

"*Northbridge* (population 4,030), Rockdale Mills, Blackstone River. The superintendent of this mill thinks that the same variety of fish may be found in the river a short distance below here, but in comparatively small numbers. The chevin is not seen here at all, and the pickerel rarely."

"Complaint is made of the bad condition of the water in the summer, and of the disagreeable odor. The water here is quite different in appearance from that a few miles below. At Farnumsville the young fish are found dead in places when the water is quiet, and are also caught from the screens. Formerly the fish could be taken in nets, but owing to the turbid condition of the water, they are never taken in that way now. Even when caught, the fish are not considered good to eat. Horses refuse to drink the water in summer."

"At Simpson's woolen mills, Millbury, the water is so bad that it cannot be used for scouring, and it is necessary to send the wool away to be cleansed. Persons obliged to work in the water for any length of time find that they suffer in health. From Millbury to Worcester, the water is in very bad condition, particularly after a rain. When the water is used for steam purposes, it is necessary to leach it to prevent foaming in the boiler. At Millbury Cotton Mill persons cannot work in the lower rooms of the mill during the hot weather, because of the bad odor coming from the

water. At some of the mills, water is pumped into tanks from the river; filth is deposited in considerable quantity in these tanks. Sample No. 30 was taken from a tank in Morse's mill, in Millbury. Millbury has a population of 4,529, but has no system of sewerage. The sewage from a part of the houses and all the mills flows directly into the Blackstone River and Singletary Brook. Singletary Brook has its rise in Singletary Pond, the water of which is very pure and clear. The pond makes a natural storage-basin for the water. From the mills, at the lower part of the brook, there is complaint that the water is rendered bad for dyeing purposes by the mills above; it also gives trouble in the steam boilers."

"Ramshorn Brook rises in a country considerably elevated above Kettle Brook, to which it is tributary; land free from limestone, and favorable for farming. Mumford River is controlled by the large storage-reservoirs at the head; the mills seldom have trouble from high water. Rock at head of the river is wholly granite. West River rises in Upton; hills at its source quite high, and wholly granite. Mill River; country at the source very much broken; ledges are wholly granite."

"*City of Worcester.*—Worcester is supplied with water from Lynde Brook. For an additional supply, it is proposed to take Kettle Brook or Tatnick Brook. Careful measurements of the volume of water used by the city have not been made, but it is estimated that the 36,000 water consumers (the whole population being 49,268) are now using about 3,000,000 gallons per day. More than 500 meters are placed in dwellings, and the quantity of water so measured indicates a small consumption for domestic purposes; while the amount used by manufactories, measured in the same way, is more than half the daily supply. The volume of water flowing from the sewers of the city in dry weather would be nearly 2,000,000* gallons in twenty-four hours. Nearly all the sewage flows into Mill Brook, and thence into Blackstone River; a small amount, however, from the west side of the city, reaches the river through Beaver Brook; this might without difficulty be directed into Mill Brook.

*A large amount of water is supplied to railroads, and does not pass off by the sewers, being carried away by the locomotives.

In addition to the sewage of the city, Mill Brook has a dry-weather flow of 4,198,000 gallons per day, as measured in 1871, at a point above where the city empties its sewage."

"Below Worcester the country seems to be finely adapted for the purpose of sewage-irrigation, or filtration. On both sides of the river the interval is quite wide, and soil of sandy nature. The higher land is gradually undulating; soil mostly loam and gravel, with very little if any clay. The character of the soil, position, and inclination of the land, and the convenience with which the sewage may be brought to it, seem to give to this section peculiar advantages for utilizing sewage. The surface of water where Mill Brook joins the Blackstone River, is 438 feet above tide-water; the reservoir on Lynde Brook is 828 feet above tide-water; and Catholic College Hill is 693 feet above tide-water. The valley of the Blackstone is entirely free from limestone; the rock is almost wholly granite, particularly about the head waters. The land about the head of West River is quite high, and in some cases bold in its slopes."

"About Worcester the country is considerably broken, and some of the hills have quite a height; the ascent is, however, usually gradual. The color of the water below the point where it would seem to be influenced by the sewage from Worcester, is light brown, and clear. It is not difficult to trace the sewage of Worcester by the color of the water alone for seven miles at least below the city."

Neponset River.

The manner in which the water-power of the Neponset River Valley is occupied, will now be described. The following list, in tabular form (see Table, pp. 90–93), comprises the mills, factories, and other works on the stream of this valley, as noted this season on the ground by Mr. C. D. Ward, assistant engineer.

The number of manufacturing establishments on this stream is in much larger proportion than on the Blackstone, when compared with the area of that valley. Mr. Ward adds the following notes :—

"None of the villages are sewered. At Canton seventeen tenements have water-closets and drains that connect with the river. The village of Hyde Park, with a population of five or six thousand, has no sewers to mention, neither does there appear to be any land in the vicinity suitable for irrigation."

"*Minerals, rocks, etc.*—The surface of the country is generally rolling, the highest hill, Blue Hill, having an elevation of 635 feet above tide; the other hills are much lower. Between the points B and C there is a long and wide extent of level and wet meadow called Purgatory Swamp. The rocks are generally igneous or slaty in their nature. At the south-eastern corner of the town of Medfield, not far from the village of Walpole, there is a limited tract of limestone, which is marked on the map. There was at one time a lime-kiln in operation there. There are also slight traces of iron in the vicinity of Walpole."

"*Water and Fish.*—Water is not taken by any village from the river for domestic use. At Walpole there are complaints made that the mills and factories in that vicinity have polluted the river to such an extent that the fish have been killed. In other parts of the river pickerel, perch, eels, bullpouts, sunfish, and suckers abound. Horses and cattle drink the water in all parts of the river."

River Statistics of Neponset Valley.

Name of Stream or River.	Letters corresponding with Letters on Map.	DESCRIPTION OF MILL.	Location.	No. of Hands Employed.	Head and Fall.	Quantities of Materials Used, &c.
					Feet.	
Pine-Tree Brook,	A	Davis Wool-Pulling Mill, . . .	Milton, . .	3	–	Some lime used.
Neponset River, .		Eagle Paper Mill, ...	"Lower Mill,"	35	12	Make two tons of book-paper a day from rags.
		Fuller Paper Mill, ...	Mattapan, .	55	8	Make one ton of cover-paper a day from rags.
		Mattapan Paper Mill, ...	Hyde Park, .	50	8	Make two tons of lithographic-paper a day from rags.
	a[1]	Hyde Park Woolen Mill (steam), . .	Hyde Park, .	325	–	21 sets of machinery. Not started yet. To make cassimeres.
Mother Brook, .	a[2]	Brainard Milling Machine Co. (steam),	Hyde Park, .	50	–	12,500 spindles.
		Smithfield Man'f'g Co. Cotton Mill, .	Readville, .	150	6	
		Walnut Hill Woolen Mill, . . .	Mill Village, .	125	10	Seven sets machinery. Fancy cassimeres.
		Saw Mill, ...	Mill Village, .	–	10	
		Merchants' Woolen Mill, . . .	Mill Village, .	550	10	29 sets of machinery. Beavers and cassimeres.
		Woolen Scouring-house, ...	Mill Village, .	–	5¼	
	a[3]	Dedham Gas Works; supply also Hyde Park.	Mill Village, .	–	–	Use 600 tons of coal a year, say 5,000,000 cu. ft. gas.
	B	[illegible]	Mill Village, .	60	–	Use some logwood, copperas, and sugar of lead. Classed [illegible]

Branch,	C	Canton Woolen Mill (steam),	Canton,	300	-	Use 6,000 lbs. muriatic acid a year and aniline colors; make jackets, shawls, etc.
Massapoag Brook,		Neponset Cotton Factory,	Canton,	175	16	10,000 spindles.
		Neponset Cotton Factory, Rosin Gas Works.	Canton,	-	-	100,000 c. ft. gas a year.
Beaver Brook,		Read Hardware M'f'g Co.,	Canton,	50	27	
		Chas. Draper, Knitting Mill,	Canton,	75	18	Cotton and woolen cardigan jackets.
Steep Brook,		Joshua Brittain, Awl Factory,	Stoughton,	6	10	
		C. Southworth, Cotton and Woolen Yarn,	Stoughton,	14	14	Three sets machinery.
		L. & G. Southworth, Iron Screws,	Stoughton,	6	10	
		French & Ward's Woolen Mill,	Stoughton,	200	20	Six sets machinery; make cardigan jackets, etc.
		A. Southworth & Co., Cotton Mill,	Stoughton,	12	12	500 spindles; make twine, etc.
Massapoag Brook,		American Net & Twine Co.,	Canton,	50	24	Mostly twisting.
		G. H. Mansfield & Co.,	Canton,	12	6	Fish-line and lamp-wick.
		Seavey, Foster & Bowman, Silk Mill,	Canton,	150	6	Color 1,700 lbs. a week.
		Seavey, Foster & Bowman, Silk Mill,	Canton,	100	11	No coloring here.
		Kinsley Iron & Machine Co.,	Canton,	225	14	
Beaver Brook,		Ames Shovel Works,	Canton,	24	13	
Massapoag Brook,		Lothrop Trowel Factory,	Sharon,	14	7	
		Revere Copper Co., Refining and Rolling,	Canton,	80	20	Use 3 carboys of sulphuric acid a month.
		Mann's Belting Duck Mill,	Sharon,	25	23	1,280 spindles; make 30,000 lbs. a week of duck.
		Lathrop's Cutlery Factory,	Sharon,	25	18	

River Statistics of Neponset Valley—Continued.

Name of Stream or River.	Letters corresponding with Letters on Map.	DESCRIPTION OF MILL.	Location.	No. of Hands Employed.	Head and Fall.	Quantities of Materials Used, &c.
					Feet.	
Massapoag Brook,		Lathrop's Cutlery Factory,	Sharon,	20	14	
Branch,		Lyman Smith's Sons, Tannery,	S. Dedham,	50	-	300,000 sheep-skins a year.
Neponset River,		Geo. Morrill, Printing-Ink Factory,	E. Walpole,	12	7	No pollution.
		Geo. Morrill, Gas Works,	E. Walpole,	-	-	31,000 c. ft. gas from coal.
Budding Brook,		Winslow Brothers, Tannery,	E. Walpole,	70	10	400,000 sheep-skins a year.
		Isaac Ellis & Co., Paper Mill,	E. Walpole,	12	18	Make one ton of binders' boards a day.
Neponset River,	C[1]	H. W. Tilton, Foundry (not working),	Walpole,	-	8	
		H. W. Tilton, Spring Factory,	Walpole,	50	9	
		F. W. Bird, Wrapping-Paper,	Walpole,	20	17	1½ tons made a day.
		Hollingwood, Wrapping-Paper,	Walpole,	7	12	One ton made a day.
		F. Morse, Grist Mill,	Walpole,	3	14	One run of stone.
	C[2]	Ira Gill, Felt Hat Man'f'y,	Walpole,	24	12	Make 60 doz. a day. Dye very few.
Spring Brook,		Diamond Twine and Canvas Factory,	Walpole,	6	15	500 spindles.

Mill Brook, . .		E. Frank Lewis & Co., Wool Sorting, .	Walpole, . .	12	11	4,000 lbs. wool a day; use 5,000 lbs. of alkalies a year.
Neponset River, .		Willard Lewis, Cotton Batting Mill, .	Walpole, . .	70	10	Two tons a day. Dust and dirt sold for manure.
		Walpole Color Works, ...	Walpole, . .	13	-	Made from chemicals; weak tannic and sulphuric acid run away from the works.
		S. Gray & Co., Bleachers and Dyers, .	Walpole, . .	12	-	80,000 lbs. bleaching and 130,000 lbs. dyeing done a year; logwood, bleaching-powders and aniline colors used.
		J. B. Cram, Hair Curling Factory, . .	Walpole, . .	24	19	Curl 225 tons a year; use 3,600 lbs. logwood, 1,200 lbs. sugar of lead, 3,600 lbs. copperas, and 2,400 lbs. soap a year.
		Blackburn's Foundry, ...	Walpole, . .	-	9	Not used for years.
Branch, . .		Wm. Cary, Jr., Shoddy Mill, . . .	S. Walpole, .	3	10	Manufacture one ton a week.
Neponset River, .		Clark's Woolen Mill, ...	S. Walpole, .	18	19	Make 62,000 lbs. woolen yarn a year; three sets of machinery; use 1,000 lbs. soda-ash a year.
	d	Wm. H. French, Shoddy Mill, . . .	S. Walpole, .	3	11	

Summary for Neponset Valley.

	Number.	Operati Employ
Woolen Mills,	11	1,5
Cotton Mills,	11	6
Machine-Shops and Foundries,	12	5
Silk Factories,	2	2
Paper Mills,	6	1
Tanneries,	2	1
Bleaching and Dyeing,	1	
Chemical Works and Curled Hair,	2	
Gas-Works,	3	
Grist and Saw Mills,	2	
Total,	52	3,3

Analysis of Statistics.

The two following tables give the general statistics of a of the leading points on the streams of the Neponset Val for comparison with the results of the analysis of waters ta from the same points, and from the head waters, before t are exposed to pollution.

Summary for certain points in the Neponset Valley.

SEE THE POSITIONS OF THESE LETTERS ON THE MAP,	A	B	C	c¹	c²	d
Drainage-area in square miles above the point indicated,	116	99.5	77.5	30.0	24.5	5.0
Dry-weather flow in 24 hours at respective points in cubic feet,	3,271,104	1,719,360	1,339,200	518,400	423,360	86,400
Dry-weather flow at respective points in U. S. gallons,	24,467,857	12,860,812	10,017,216	3,877,632	3,166,732	646,272
Number of polluting factories or mills,	52	42	40	16	12	-
The same per square mile,	0.45	0.42	0.52	0.53	0.49	-
Number of operatives in said factories, mills, etc.,	3,388	2,045	1,685	290	213	-
Population in basin above the respective points in 1875,	23,413	13,273	12,331	2,428	1,975	175
Population in basin above the respective points per square mile,	201.84	133.49	159.11	80.90	80.61	35.00
Population of cities, villages, mills, or works now sewering into the river above said points.	2,751	1,533	1,473	215	158	-
Population of this character per square mile,	23.72	15.41	19.01	7.17	6.45	-

NOTE.—The flow between A and B (see map), is augmented by a draft from the Charles River through "Mother Brook." The amount which can be withdrawn in this way from Charles River is limited to one-third of its flow.

Analysis of the Waters of the Neponset River, taken from the points indicated in the previous Table.

[Parts per 100,000.]

Date.	Letters on Map.	Locality.	Ammonia.	"Albuminoid Ammonia."	Solid Residue.		Chlorine.	Oxygen required.
					Organic.	Total.		
July 28, 1875,	d	S. Walpole above all pollution,	.0091	.0325	2.52	4.40	0.28	0.790
Aug. 6, 1875,		S. Walpole above all pollution,	.0085	.0176	1.92	3.76	0.27	0.792
" 6, 1875,	c^2	Walpole at Bridge,	.0052	.0171	2.76	5.04	0.38	1.165
" 6, 1875,	c^1	Bridge above Ink Works,	.0075	.0149	2.12	4.88	0.36	0.664
" 7, 1875,	C	Between S. Canton and Dedham,	.0085	.0192	2.04	5.04	0.50	0.725
" 6, 1875,	B	Above junction with Mother Brook,	.0080	.0197	1.92	5.04	0.51	0.684
" 6, 1875,	A	Milton Lower Mills above Baker's dam,	.0123	.0160	2.16	5.56	0.48	0.668

Taking in each case its head waters as the standard of purity for each particular valley, the above analysis, when compared with that standard, exhibits the effect of the trades-pollutions received as we follow down stream; but it cannot be said to show a degree of pollution here which would render the water unfit for general use, agreeing in this with the report of Mr. Ward, who states that "horses and cattle drink the water in all parts of the river." There are complaints, notwithstanding, reported from Walpole that the refuse fluids from mills and factories in that vicinity have killed the fish.

It is to be noted of the state of this river, as was remarked of the Blackstone, that the stream, although low, was not at its very low dry-weather stage, which occurs generally in October or November, but in some seasons not at all. In extreme low water the pollution received would be rendered more perceptible.

Of the waters of this valley, Prof. Nichols says: "The waters are all slightly alkaline, are somewhat colored, and deposit a slight sediment when allowed to stand quietly."

Charles River.

The statistics of the Charles River Valley will now be presented, as they were taken this season by the assistant engineer, Mr. E. K. Clark. They are here given in the same tabular form as for the other rivers.

Mills, Factories, etc., in the Charles River Valley.

Name of River or Stream.	Letters corresponding with Letters on Map.	DESCRIPTION OF MILL.	Location.	No. of Hands Employed.	No. of Spindles.	Head and Fall. Ft. In.	Sets of machinery.	Quantities of Materials used per year, so far as known.
Charles River, .	A	Walker Pratt & Co., Foundry,[1] . . .	Watertown, .	140	-	4 6	-	Use some acid in pickling castings.
		Grist Mill,[1]	Watertown, .	3	-	4 6	-	3 run of stones.
		Paper Mill,[1]	Watertown, .	80	-	4 6	-	
		Ætna Woolen Mill, ...	Watertown, .	250	-	4 2	12	300,000 lbs. material.
		Waltham Cotton Mills,[2]	Waltham, . .	626	-	12	-	
		Bleachery,[2]	Waltham, . .	213	-	-	-	At cotton and hosiery mills use 269,000 lbs. cotton.
		Hosiery Mill,[2]	Waltham, . .	351	-	-	-	
		Rice Paper Mill,[3]	Newton L. Falls,	8	-	5 6	-	
		Shoddy Mill,[3]	Newton L. Falls,	25	-	5 6	-	
		Dudley Hosiery Co.,[3]	Newton L. Falls,	50	-	6	-	48,000 lbs. cotton and wool.

Charles River,		Paper Mill (not finished),[5]	Newton U. Falls,	-	-	-	-	
		Newton Cotton Mills,	Newton U. Falls,	200	1,500	14	-	672,000 lbs. cotton.
	B	(Above junction of Mother Brook.)						
		Paper Mill,[6]	Charles Riv. Vill.,	14	-	9 2	-	
		Paper Mill,[6]	Charles Riv. Vill.,	14	-	9 2	-	
		Grist Mill,[7]	S. Natick,	-	-	7	-	Man'f'g leather board, use no rags.
		Paper Mill,[7]	S. Natick,	15	-	7	-	
	C	(At mouth of Harding Brook.)						
		Campbell's Paper Mill,	S. Natick,	7	-	4	-	
		Rockville Cotton Mill,	Medway,	35	1,500	7	-	
		Cotton-Batting Mill, Eaton & Wilson,	Medway,	15	-	6	-	660,000 lbs. cotton.
		Cotton-Batting Mill, Eaton & Wilson,	Medway,	15	-	11	-	330,000 lbs. cotton.
	b	Medway Flock Co.,	Medway,	4	-	15	-	Washings from rags go into the water.
	a	Campbell's Paper Mill,	Medway,	20	-	12	-	
		Careyville Woolen Mills,	Medway,	90	-	11	7	450,000 lbs. wool, 15,000 lbs. soda-ash.
	c	Ray Woolen Mill,	N. Bellingham,	51	-	12	4	24,000 lbs. woolen material.
		Shoddy Mill, F. B. Ray & Co.,	Bellingham,	3	-	11	-	
		Grist and Saw Mill, J. B. Ray & Co.,	Bellingham,	-	-	10	-	
		Grist Mill,	Milford,	-	-	20	-	

[1] At one dam. [2] Belong to Boston Manufacturing Co. [3] At one dam. [4] At one dam. [5] At one dam. [6] At one dam, owned by one party. [7] At one dam.

Mills, Factories, etc., in the Charles River Valley—Continued.

NAME OF RIVER OR STREAM.	Letters corresponding with Letters on Map.	DESCRIPTION OF MILL.	Location.	No. of Hands Employed.	No. of Spindles.	Head and Fall.	Sets of Machinery.	Quantities of Materials used per year, so far as known.
Beaver Brook, .		Beaver Brook Netting Mills, . . .	Waltham, . .	40	–	Ft. In. 16	–	
		Silk Factory, ...	Waltham, . .	40	–	9 6	–	
Stony Brook, .		Roberts' Paper Mill, ...	Waltham, . .	12	–	16	–	1,500 tons stock.
		Stony Brook Machine Co., ...	Waltham, . .	60	–	23	–	
		Hall's Shoddy Mill, ...	Waltham, . .	4	–	27	–	
		Saw Mill, ...	Waltham, . .	–	–	8	–	
Sibley Brook, .		Shattuck's Furniture M'f'y, ...	Waltham, . .	4	–	27	–	
		Brown's Tool M'f'y, ...	Waltham, . .	2	–	21	–	
Hobos Brook, .		Grist Mill, ...	Waltham, . .	–	–	28	–	
Reservoir, . .		Foundry and Machine-Shop, Pattee & Co.,	Newton U. Falls,	175	–	18	–	Pickle castings in acid.
Waban Brook, .	d	Wood's Paint Mill, ...	Natick, . .	22	–	13	–	
		Jenning's Saw Mill, ...	Natick, . .	–	–	13	–	

Boggistow Br'k,		Collins' Saw Mill,	Sherborn,	-	2	8	-	
		Box Factory,	Medway,	-	3	5	-	
		Saw Mill,	Medway,	-	4	4	-	
		Stetson & Talbot, Nail M'f'y,	E. Holliston,	-	15	13	-	
		Payson's Saw & Box Factory,	E. Holliston,	-	5	10	-	
	g	(The Head Waters,)	E. Holliston.					
Chicken Brook,		Thayer's Machine Shop,	Medway,	-	4	11	-	
		Box Factory,	Medway,	-	3	9	-	
		Saw and Grist Mill,	Medway,	-	-	9	-	
Hopping Brook,		Box Factory and Saw Mill,	Careyville,	-	-	10	-	
Harding Brook,		Harding Saw Mill,	Medfield,	-	-	14	-	
		Saw Mill,	Medfield,	-	-	14	-	
Medfield Brook,		Cushman's Carriage Manufactory,	Medfield,	-	-	8	-	
		Cushman's Carriage Manufactory,	Medfield,	-	12	10	-	
Stop River,		Campbell's Paper Mill,	Norfolk,	-	12	16	-	
		Ray Shoddy Mill,	Norfolk,	-	4	15	-	
Milk River,		Franklin Woolen Man'f'g Co.,	Norfolk,	-	60	18	-	
		Shoddy Mill,	Norfolk,	-	2	4	-	
		Grist Mill,	Norfolk,	-	-	9	-	
	i	(The Head Waters,)	Norfolk.					

Mills, Factories, etc., in the Charles River Valley—Concluded.

Name of River or Stream.	Letters corresponding with Letters on Map.	Description of Mill.	Location.	No. of Hands Employed.	No. of Spindles.	Head and Fall.	Sets of Machinery.	Quantities of Materials used per year, so far as known.
						Ft. In.		
Mine Brook, .		Daniels' Box Man'f'y, ...	Franklin, . .	4	-	8	-	
		Ray Felting Mill, ...	Franklin, . .	16	-	12	-	300,000 lbs. wool; scour large amount of wool.
		Shoddy Mill, ...	Franklin, . .	7	-	16	-	
		Felting Mill, J. B. Ray, ...	Franklin, . .	20	-	14	-	

Summary for Charles River Valley.

	Number.	Operatives Employed.
Woolen Mills,	14	336
Cotton Mills,	8	1,542
Paper Mills,	10	200
Iron Manufactories,	7	406
Paint Mills,	1	213
Saw Mills and Grist Mills,	1	40
Bleachery,	1	22
Silk Manufactories,	1	40
Total,	43	2,759

Additional Notes by Mr. Clark, Assistant Engineer.

"From Boston Harbor to Watertown, Charles River is a tidal stream. In this distance it receives a large amount of sewage from Boston, Cambridge, Somerville and other sources."

"*Watertown* (population 5,099) has no system of sewerage at present; surveys have been made with the intention of establishing a complete system of drainage which shall discharge into Charles River."

"*Waltham* (population 9,945) takes water from a reservoir near Charles River, at a point about one mile above the town. No system of sewerage has been perfected; in two or three of the main streets sewers have been built which empty into the river."

"*Newton* (population 16,105). The sewage from a part of the city goes into Charles River; cesspools are quite extensively used, the contents of which are removed once or twice during the year. Water-works are in process of construction; water is to be taken from a reservoir near Charles River a little above Newton Upper Falls."

"*Dedham* (population 5,756) has no water-supply or sewerage system; proposes taking water from a reservoir to be built near Charles River. A portion of Dedham drains into Neponset River through Mother Brook."

"*Needham* (population 4,536), *Dover* (population 650), and a part of *Natick* (population 7,419) drain indirectly into the river. Much of the sewage of Natick finds its way into Cochituate Lake, although the town has not yet sewers. Along the river from Boston to Natick the soil is favorable for the utilization of sewage, although it might be necessary to pump it to get sufficient area. The country, located as it is, near Boston, and possessing many natural advantages, makes it desirable as a place of residence; and it is being rapidly taken for this purpose. The value of the land is increasing from year to year, and at the same time the amount of sewage discharged into the water along this part of the river is increasing. The opinion has been given that the river below Natick should be regarded as a sewer, and walled in; while above this point the water should be kept as free from pollution as possible, with the intention of using the upper water in the towns. All the towns above Natick discharge more or less sewage directly into the river."

"*Medway* (population 4,237) is situated almost wholly on the river, and drains into it."

"*Holliston* (population 3,339) is so situated that the sewage from a large part of the town must flow directly into the river."

"*Milford* (population 9,818) is a town of considerable importance; has no water-supply or system of sewerage. In the principal street a sewer has been built which empties into Charles River. The surface-drainage is quite effectual, and flows directly into the river over the meadows, which have increased in value from the larger crops of grass they produce than formerly. A small amount of refuse escapes into the river from the gas-works. Before the mills on the lower part of the river were built, pickerel and trout were quite abundant; now there are comparatively few. The soil about Milford is a sandy loam, and the sewage could without difficulty be conveyed upon some of the low land in the neighborhood."

"The rock about the upper waters of the Charles River is

granite. It has been proposed to divert the sewage of Milford from the Charles River into the Blackstone. The land about the head of the Charles River is gradual in its ascents; the rock is almost wholly granite. The valley is entirely free from limestone. The water of the Charles is tolerably clear, and light brown in color, with the exception of the two cases before mentioned,—Cedar Swamp Pond, whose water does not seem to be very clear, and the water of Boggistere Brook, in Holliston, which is a little darker in color, but still transparent."

"The Brighton abattoir is situated upon tide-water of the Charles River. At this establishment there are killed about 1,700 head of cattle and 6,000 sheep per week. Most of the refuse is saved and manufactured into tallow, oil, fertilizer, glue, etc. The water in which a part of the refuse is boiled is afterwards evaporated for the glue, during the cool weather. The water used about the works is drawn from wells; there are used on an average per day, about 50,000 gallons, three-fourths of which, at least, must be used for washing purposes. This latter, as it runs from the floors, goes into a sewer, thence into the river, and is almost the whole and only kind of refuse that gets into the river. The works are neat, and are conducted so that there is the least possible waste."

"The rendering establishments above here are closed permanently."

Analysis of Statistics.

In the following two tables will be found the statistics indicating the condition of the water at certain points in the Charles River Valley, for comparison with the analyses of that water at the same points, and also from the head waters of the valley.

CHARLES RIVER VALLEY.—*This table is intended to explain the summer flow of the stream, and the amount of its previous exposure, at certain of the points whence water was taken for analysis. The points are indicated by the same letters on the map, and on the table of analyses.*

SEE THE POSITIONS OF THESE LETTERS ON THE MAP,	A	e	B f	C	K	a
Drainage-area above points indicated, square miles,	295.8	236.9	219.8	156.3	94	69.8
The same, deducting one-third for points below Mother Brook, square miles,	197.2	158	-	-	-	-
Dry-weather flow at respective points in 24 hours, cubic feet,	3,407,616	2,730,240	3,798,144	2,700,864	1,624,320	1,206,144
" " " " " U. S. gallons,	25,488,967	20,422,195	28,410,117	20,202,462	12,149,913	9,021,957
Number of polluting factories or mills,	43	23	22	17	13	8
" " " " per square mile,	0.12	0.09	0.1	0.11	0.14	0.11
Number of operatives in said mills,	2,759	620	445	365	307	211
Population in basin above respective points, 1855,	44,510	28,714	24,975	16,697	12,987	10,204
" " " " 1870,	62,605	39,184	32,573	21,982	18,033	13,000
" " " " 1875,	71,153	43,781	35,469	25,389	21,129	13,400
" " " " 1875, per square mile,	273.8	184.8	161.3	162.4	224.7	192
Population of cities, villages and mills sewering into the river above the points indicated, 1875.	21,511	13,887	12,205	8,278	6,513	4,971
Population of this character per square mile,	72.7	58.6	55.5	52.9	69.3	71.2

Analysis of the Waters of the Charles River.

[Parts per 100,000.]

Date.	Letters on Map.	LOCALITY.	Ammonia.	"Albuminoid Ammonia."	Solid Residue. Organic.	Solid Residue. Total.	Chlorine.	Oxygen required.
Oct. 1, 1875,	g	East Holliston Pond above all pollution,	.0083	.0208	1.48	3.92	0.36	-
" 1, 1875,	i	Whiting Pond above all pollution,	.0059	.0107	0.84	3.00	0.28	-
Aug. 31, 1875,	a	Charles River, Medway,	.0128	.0229	2.32	5.04	0.40	0.635
Oct. 1, 1875,	K	Charles River below Mill River,	.0069	.0187	1.48	4.64	0.48	-
Aug. 24, 1875,	C	Charles River below Bellingham,	.0059	.0299	3.00	6.20	0.35	0.990
" 31, 1875,	B f	Charles River, Dedham,	.0096	.0328	2.72	5.40	0.36	0.868
" 31, 1875,	e	Charles River above Newton Lower Falls,	.0080	.0293	2.92	5.60	0.40	1.043

From this table it can hardly be asserted that the Cha River water above Newton Lower Falls, if properly filter is unfit for domestic use, and yet the river has received polluting refuse of forty-two mills and factories, and is in tl respect very much in the same condition as the Thames abo London, having, however, a greater population per square m than the Thames basin. The country seems destined to up fast on the lower portions of this basin convenient Boston, and the prospect, therefore, of a large addition to tl sewage-pollution of the stream is certain within the next te years, unless, in the meantime, some mode of meeting an controlling the evil is made applicable.

The most of the samples of water analyzed in this tabl were taken from the river late in August at a low summer stage of the stream; but they cannot be said to have been taken during its lowest dry-weather stage which usually occurs later, and in that case would have shown more distinctly the contaminations received. This low dry-weather stage following a season of low rainfall, does not occur every season, and has not thus far (November) occurred this year. The samples analyzed give probably a fair view of the character of the water during its usual summer stage.

Chicopee River.

The river-statistics of the Chicopee Valley will now be given as they were gathered this season by the assistant engineer, Mr. Charles D. Ward. This is the largest river-basin within the State, comprising an area of seven hundred and eighteen square miles, of which two hundred and eighty-six square miles remain at this date uncontaminated by any polluting refuse other than what may proceed from farming operations and a very scattered population. There is no trades-pollution on this portion, nor any concentrated sewage.

To the tabular statement here given (see pp. 110–118), Mr. Ward adds the following notes:—

In the large district, above point C on the map, "the sewage is a very small matter, as there are no large towns."

"At West Warren, seventy tenements, perhaps five or six persons in each, are connected with the river by drains, but simply sink and surface water enter them, as the water-closets do not connect.

"Nearly all the water-closets of the factories and mills, employing 2,340 hands, in those visited and noted, empty directly into the river.

"*Minerals, etc.*—This whole division seems to be composed of igneous rocks.

"There is iron scattered through a large part, especially a few miles south of North Dana, where an old abandoned mine is shown, and another a few miles north-east of Gilbertville.

"There are also strong iron-springs at Coldbrook, and near West Warren, which are used medicinally.

"The hills are from two hundred to five hundred feet in height."

Between B and C on the Map.

"*Sewage.*—At Three Rivers there are a few drains that take sink-water from about three hundred persons, but very few water-closets connect: at Bond's Village, or Duckville, about one hundred and fifty, under same conditions. At Thorndike, thirteen tenements; about five in each are drained, but no water-closets.

[See page 119.

Mills, Factories, etc., in the Chicopee Valley.

NAME OF STREAM OR BRANCH.	Letters corresponding with Letters on Map.	DESCRIPTION OF MILL, ETC.	Location.	No. of Hands Employed.	No of Spindles.	Head and Fall.	Sets of Machinery.	Quantities of Materials used per year, so far as known.
						Feet.		
Chicopee River,		Byrt & Bullens, Tanners, etc.,	Chicopee,	7	–	–	–	5,000 hides tanned a year.
		E. Wood & Son, Saw and Grist Mill,	Chicopee,	–	–	7	–	Two run of stones.
		Dwight M'f'g Co., Cotton Mills,	Chicopee,	1,500	110,000	30	–	
		Dwight M'f'g Co., Gas Works,	Chicopee,	–	–	–	–	4,000,000 cub. feet gas.
		Ames M'f'g Co., Iron [redacted] Brass W'ks,	Chicopee,	300	–	–	–	Ten tons oil of vitriol.
		Gaylord M'f'g Co., Lock Factory,	Chicopee,	60	–	8	–	Four tons oil of vitriol.
	A a'	Chicopee Man'f'g Co., Cotton Mills,	Chicopee Falls,	1,200	62,100	–	26	
		Chicopee Man'f'g Co., Gas Works,	Chicopee Falls,	–	–	–	–	390 tons coal estimated to make 3,250,000 cub. feet gas.
		Lamb Knitting-Machine M'f'g Co.,	Chicopee Falls,	[redacted]	–	8	–	One ton oil of vitriol.
		Bay State Dye and Alpaca W. W'ks,	Chicopee Falls,	6	–	7	–	
		Belcher & Taylor, Agricultural Tools,	Chicopee Falls,	60	–	16	–	Four and a half tons oil of vitriol.
Branch of Chicopee R.,		Hampden Bleaching Co.,	Chicopee Falls,	20	–	–	–	75 tons oil of vitriol, 54 tons chl. lime, 9 tons soda-ash, 50 bbls. lime.
Chicopee River,		J. Stevens & Co., Pistol Factory,	Chicopee Falls,	35		6		

Mills, Factories, etc., in the Chicopee Valley—Continued.

Name of Stream or Branch.	Letters corresponding with Letters on Map.	Description of Mill, Etc.	Location.	No. of Hands Employed.	No. of Spindles.	Head and Fall.	Sets of Machinery.	Quantities of Materials used per year, so far as known.
Ware River,		Thorndike Co., Cotton Mill,	Thorndike,	360	14,064	Feet. 18	–	
		Gilbert M'f'g Co., Woolen Mill,	Ware,	250	–	5½	7	
		C. A. Stevens & Co., Woolen Mill,	Ware,	175	–	18	10	
		Otis & Co., Cotton Mill,	Ware,	300	8,448	16	–	
		Otis & Co., Cotton Mill,	Ware,	150	7,872	17	–	
		Otis & Co., Cotton Mill,	Ware,	180	8,896	26	–	
	[1]C	Otis & Co., Gas Works,	Ware,	–	–	–	–	240 tons coal, estimated to produce 2,000,000 cub. feet gas.
Branch,	B	J. Beebe & Son, Woolen Mill,	Monson,	60	–	12	5	
		Harrison Day, Saw and Grist Mill,	Monson,	–	–	8	–	Two run of stones.
		Merrick, Fay & Co., Straw Hat W'ks,	Monson,	325	–	–	–	30 tons soda, 50 bbls. brimstone, 2,000 lbs. sugar of lead, 2,000 lbs. oxalic acid, 6,000 lbs. dyewood, 500 lbs. bichromate of potash and 500 lbs. copperas.
		Lyons Woolen Mill,	Monson,	50	–	12	4	

Mills, Factories, etc., in the Chicopee Valley—Continued.

Name of Stream or Branch.	Letters corresponding with Letters on Map.	DESCRIPTION OF MILL, Etc.	Location.	No. of Hands Employed.	No. of Spindles.	Head and Fall.	Sets of Machinery.	Quantities of Materials used per year, so far as known.
						Feet.		
Ware River,		Page Paper Co.,	Hardwick,	40	–	9	–	320 bbls. common lime, 80 tons alum, 60 tons bleaching-powders; make news-paper.
		Holden's Saw and Grist Mill,	Barre,	–	–	10	–	Two run of stones.
		Dennyville Woolen Mill,	Barre,	75	–	8½	4	
		American Powder Co.,	Barre,	–	–	14	–	Given up.
		Smithville Cotton Mill,	Barre,	80	4,500	19	–	
Cold Brook,		Whiting's Machine-shop,	Coldbrook,	15	–	13	–	
		Matthews' Agricultural Tools,	Coldbrook,	6	–	6	–	
Natty Pond Brook,		John Woodard's Tannery,	Hubbardston,	2	–	8	–	500 hides and calf-skins.
Burn Shirt River,		Howard's Saw Mill,	Barre,	–	–	10	–	
		Holland's Saw Mill,	Barre,	–	–	10	–	
		Williams & Browning Chair Factory,	Williamsville,	20	–	12½	–	
		S. P. Hale, Saw Mill,	Williamsville,	–	–	16	–	
		E. R. Brown, Saw Mill,	East Phillipston,	–	–	10	–	
		[illegible] Mill,	[illegible] Phillipston,	–	–	11	–	

Name of Stream or Branch.	Letters corresponding with Letters on Map.	DESCRIPTION OF MILL, Etc.	Location.	No. of Hands Employed.	No. of Spindles.	Head and Fall.	Sets of Machinery.	Quantities of Materials used per year, so far as known.
						Feet.		
Quaboag River, . .	C¹ & C²	B. A. Tripp, Boot Factory, . .	Warren, . . .	60	–	–	–	
Branch, . . .		L. J. Knowles, Pump Works, . .	Warren, . . .	150	–	18	–	Steam-pump manufactory.
Quaboag River, . .		L. J. Knowles, Cotton Warp, . .	Warren, . . .	22	1,200	6	–	
		Gould's Plaster and Grist Mill, .	Warren, . . .	–	–	6	–	Three run of stones.
East Brookfield River,		Saw and Grist Mill, ...	East Brookfield, .	–	–	–	–	Two run of stones.
		Foundry, ...	East Brookfield, .	12	–	–	–	
		Brookfield Cotton Mill, . . .	East Brookfield, .	75	3,200	16	–	
Seven Mile River, .		Forbes & Fay, Wheel Factory, .	East Brookfield, .	10	–	17	–	
		Westville Woolen Mill, . . .	Spencer, . . .	30	–	10	2	
Branch, . . .		Livermore's Box Factory, . .	Spencer, . . .	8	–	24	–	
		Beemer's Saw and Grist Mill, . .	Spencer, . . .	3	–	18	–	One run of stones.
		Spencer Woolen Mill, . . .	Spencer, . . .	40	–	30	2	
		Spencer Woolen Mill, . . .	Spencer, . . .	40	–	22	2	

Branch, . . .		James Capin, Grist Mill, . . .	Spencer, . .	-		27	-	One run of stones.
		Watson's Wood Planing Mill, . .	Spencer, . . .	-	-	[illegible]	-	
Seven Mile River, .		Samuel Barnes & Co., Planing Mill,	Spencer, . . .	-	4	7	-	
Turkey Hill Brook, .		Proutey's Wire Mill, ...	Wire Village, . .	8	-	21	-	13½ tons of oil of vitriol.
		Proutey's Wire Mill, ...	Wire Village, . .	14	-	26	-	4½ tons of oil of vitriol.
		Sugden's Saw Mill, ...	Wire Village, . .	-	-	10½	-	
		Sugden's Wire Mill, ...	Wire Village, . .	10	-	28	-	18 tons of oil of vitriol.
		Sugden's Wire Mill, ...	Wire Village, . .	24	-	14	-	Nine tons of oil of vitriol.
Shaw Brook, . .	d°	Sugden's Wire Mill, ...	Wire Village, . .		-	30	-	

Summary.

	Number.	Operatives Employed.
Cotton Mills,	18	6,228
Foundries and Machine-shops,	33	1,102
Woolen Mills and Dye Works,	26	1,028
Bleaching Works,	1	20
Paper Mills,	3	262
Hat Works,	1	325
Tanneries,	3	19
Gas Works,	6	–
Saw and Grist Mills,	34	–
	125	8,984

river is used in the manufacture of news-paper, but it is said not to be pure enough for fine paper, on account of the iron in it.

"*Fish.*—Pickerel, perch, dace, suckers, shiners, and sunfish are caught in all parts of the river. No fish seem to have abandoned the river, but the number is reduced by being caught out. Horses and cattle drink the water in all parts of the river freely.

"At Chicopee, the upper dam, with a head and fall of thirty feet, includes the two lower ones of eight and seven feet, as they merely get what flows over the upper one. The same is true of the twenty-six-feet dam at Chicopee Falls."

Analysis of Statistics.

In the following table will be found summarized the river-statistics of some of the points from which samples of water were taken for the chemist, from which the extent of the previous pollution can be judged of and compared with its exhibition in the proper analysis.

I will give, too, from the tables of analyses, the results for the points indicated in the table just mentioned, and those also of some of the head waters of this river, for comparison :—

Analysis of the Waters of the Chicopee River.

[Parts per 100,000.]

Date.	Letter on Map.	Locality.	Ammonia.	"Albuminoid Ammonia."	Solid Residue.		Chlorine.	Oxygen required.
					Organic.	Total.		
Aug. 9, 1875,	d¹	Ware River, near Barre Falls, no pollution,	.0075	.0227	2.96	5.72	0.16	1.606
" 7, 1875,	d²	Turkey Hill Brook, above pollution,	.0123	.0171	3.20	5.08	0.16	1.373
July 22, 1875,	d³	Swift River, above pollution,	.0053	.0128	1.88	3.52	0.08	0.432
Aug. 9, 1875,	C¹	Ware River, below Gilbertville,	.0069	.0181	2.56	4.48	0.15	1.062
" 7, 1875,	C²	Quaboag River, below West Warren,	.0059	.0107	1.88	4.44	0.17	0.564
July 22, 1875,	C³	Swift River, below Enfield,	.0093	.0165	2.16	4.44	0.09	0.586
" 22, 1875,	B	Chicopee River, near Three Rivers,	.0064	.0115	2.32	4.80	0.11	0.508
" 10, 1875,	A	Chicopee River, at Dwight Dam,	.0112	.0155	2.08	5.08	0.12	0.498
" 21, 1875,		Connecticut River, immediately above Springfield,	.0085	.0139	1.68	6.12	0.09	0.393

River-Statistics, Mills, Factories, etc., of the Taunton Valley.

Name of Stream or Branch.	Letters corresponding with Letters on Map.	Description of Mill, Etc.	Location.	No. of Hands Employed.	Spindles.	Head and Fall.	Quantities of Materials used per year, so far as known.
						Feet.	
Three Mile River,	b	Dighton Furnace Co.,	Taunton,	100	–	7	1,500 tons iron, 700 tons coal.
		Dighton Pipe Works,	Taunton,	56	–		1,800 tons iron, 1 carboy sulphuric acid.
		Lincoln's Paper Mill,	Dighton,	17	–	8	386 tons paper made in 1874; 2 carboys sulph. acid, manilla and coarse packing, 3 casks bleaching-powder.
		Mount Hope Thread Mill,	Dighton,	42	–	–	93,600 lbs. cotton thread and yarn made per year.
		Westville Cotton Factory,	Taunton,	72	5,436	12	624,000 lbs. cotton thread and yarn made per year.
		Oakland Cotton Factory (A. F. Howard & Son).	Taunton,	84	3,724	8	249,600 lbs. cotton made into cloth, blue and brown; 5,840 lbs. indigo, 30,000 lbs. catch, 1,400 lbs. blue vitriol, 1,100 lbs. ext. logwood, 5,400 lbs. potash, 200 lbs. flour, 250 gals. molasses.
	c	Saw Mill,	Norton,	–	–	–	
Birch Brook,		Saw Mill,	Norton,	12	–	8	
Rumford River,		Batten and Saw Mill (L. Willis),	Norton,	–	–	7	
	e	Norton Wool Scouring Mills (F. A. Story & Co).	Norton,	12	–	8	1,200,000 lbs. wool cleaned; 2,000 lbs. soda-ash, 2 bbls. red oil. Some wool con-

Rumford River,	Saw Mill,	–	–	–	–	
	Saw and Grist Mill (Fisher Bros.),	Mansfield,	–	–	11	
	Jewelry Factory (F. W. Cabot),	Mansfield,	–	–	12	
	Jewelry Factory (Kingman & Hodges),	Mansfield,	75	–	14	Imitation rubber, gold and plated jewelry; use 10 carboys sulphuric and nitric acids.
	Knife Works (Robert Fulton),	Mansfield,	12	–	5	12,480 doz. shoe-knives, 6,240 gross awls.
	Knife Works (J & R. Murphy),	Mansfield,	13	–	12	Not in operation at present (Sept., 1875).
	Gardner Chilson's Stove and Furnace Foundry.	Mansfield,	65	–	Steam.	1,000 tons iron made into stoves, etc.; 10 carboys sulphuric acid.
	Mansfield Spindle Works,	Mansfield,	45	–	Steam.	e; use 7½ tons steel, 12 ons composition.
	Grist Mill (McAvoys),	Foxborough,	2	–	7	Runs all the year.
Billings Brook,	Shingle Mill,	Foxborough,				
	Shingle Mill,	Foxborough,	2	–	12	
Wading River,	Copper Works, Crocker, Bros. & Co.,	Norton,	25	–	21	Use 25 carboys sulph. acid, 5 carboys nitric acid.
Goose Brook,	Shingle Mill (G. H. Arnold),	Norton,	3	–	6	Run 3½ months per year.
	Shingle and Box B'd Mill (A. D. Lane),	Norton,	–	–	–	
Wading River,	Cotton Mill (Wheaton's),	Norton,	60	–	12	218,400 lbs. cotton made into white drillings.
Brook emptying into above.	Match Factory (Messenger & Sweet),	Norton,	30	–	–	1,300 lbs. phosphorus, 104 bbls. sulphur used; 49,000 gross made.
Branch of Wading River.	Saw Mill (C. D. & O. H. Lane),	Norton,	5	–	11	Run 9 months in the year.
	Saw Mill,	Attleborough,	–	–	–	

River-Statistics, Mills, Factories, etc., of the Taunton Valley—Continued.

NAME OF STREAM OR BRANCH.	Letters corresponding with Letters on Map.	DESCRIPTION OF MILL, ETC.	Location.	No. of Hands Employed.	No. of Spindles.	Head and Fall.	Quantities of Materials used per year, so far as known.
						Feet.	
Wading River,		Shingle and Saw Mill (J. T. Brannan),	Norton,	2	–	4	Runs most of the year.
		Saw, Grist and Planing Mill (Sweet Brs.),	Mansfield,	5	–	9	Runs all the year.
		Cotton Mill (J. W. Sayles),	Mansfield,	–	–	–	
		Knife Works (G. A. Robinson),	Mansfield,	17	–	12	20,000 doz. knives made; used 150 lbs. bees-wax, 100 lbs. tallow, 250 lbs. pig-lead.
		Wool Scouring Mill,	Wrentham,	–	–	8½	Has not been in operation for a year.
		Saw and Grist Mill,	Wrentham,	2	–	10½	Mill runs 4 months in the year.
Stream emptying into Shepard's Pond.		Woolen Yarn Mill (Henry Cook's),	Wrentham,	18	–	22	62,000 lbs. wool used when running full; wool also washed.
		New reservoir just above last mill,	Wrentham,			4	No mill here.
		Old dam not used now,	Wrentham,			4	
		Mill (Crowels),	Wrentham,	–	–	9½	Not in use.
		Reservoir N.W. of Shepard's Pond,	Wrentham,			7½	No mill here. Dam is not up (Sept., 1875).

River-Statistics, Mills, Factories, etc., of the Taunton River—Continued.

Name of Stream or Branch.	Letters corresponding with Letters on Map.	DESCRIPTION OF MILL, ETC.	Location.	No. of Hands Employed.	No. of Spindles.	Head and Fall.	Quantities of Materials used per year, so far as known.
						Feet.	
Little or Mill River,		Screw Manufactory, American S. Co.,	Taunton,	325	-	6	624 tons iron. Works are to be removed to Providence, R. I.
		Gas Works,	Taunton,	8	-	-	13,000,000 cubic feet gas made 1874; 17,000 tons coal used.
		Machine and Foundry Shop,	Taunton,	77	-	Steam.	35 carboys sulphuric acid.
	k	Cotton Mill (Dean Cotton & Mach. Co.),	Taunton,	85	5,360	8½	216,000 lbs. cotton made into white cloth.
		Cotton Mill,	Taunton,	42	4,064	Steam.	624,000 lbs. cotton spun into yarn.
		Cotton Mill (Chas. Albro),	Taunton,	40	7,584	15½	318,000 lbs. cotton made into white cloth.
		Britannia Works (Reed & Barton),	Taunton,	450	-	7	
	l	Cotton Mill (Whittenton M'f'g Co.),	Taunton,	900	-	15½	2,000,000 lbs. cotton made into white and colored cloth.
Canoe River,		Shingle Mill,	Norton,	-	-	-	
		Batting Mill,	Norton,	-	-	-	
		Grist and Saw Mill (J. B. Flint),	Mansfield,	4	-	14	
Branch of Canoe R.,		Tack Factory (F. A. White),	Mansfield,	-	-	16	Has not been in operation for 2 or 3 years.
Canoe River,	m	Cotton Batting Mill,	Mansfield,	-	-	9	Has not been in operation for 6 years.
		Saw Mill,	Foxborough,	-	-	-	
Leaches Stream,		Iron Foundry (T. Copeland),	Norton,	4	-	8½	Runs 4 months a year.

Branch of above,		Saw Mill,	Easton,	–	–	7	
Leaches Stream,		Saw Mill,	Easton,	–	–	10	
		Iron Foundry (Drake's),	Easton,	25	–	16	Cast 650 tons iron per year; 45 carboys sulph. acid used.
		Iron Foundry Malleable Iron (Belcher's),	Easton,	20	–	–	
		Grist Mill,	Easton,	–	–	14	
	n	Factory (Briggs),	Sharon,	–	–	–	Not in operation. Pond not kept up.
Two Mile Run,	o p q r	Saw and Grist Mill (M. G. Williams),	Raynham,	3	–	9	Runs all the year.
		Nail Mill,	Raynham,	–	–	–	Not in operation.
		Shoe Factory (W. O. Snow),	Raynham,	67	–	13	Uses $80,000 worth of stock per year.
		Saw Mill (J. Tracy & Son),	Raynham,	–	–	–	
		Tack Factory (Leeds, Robinson & Co.),	Raynham,	14	–	15	3,000 casks lath nails; 250 carboys sulph. acid.
		Saw and Planing Mill (M. Wilbur),	Raynham,	–	–	13	Run all the year.
	s	Shingle and Grist Mill (M. Wilbur),	Raynham,	–	–	–	
Damlot Brook,		Nail Factory (small one),	Raynham,	–	–	–	Not in operation.
Cotley River,		Saw Mill (H. S. Dean),	Taunton,	–	–	9	Not in operation.
		Charcoal Mill,	Taunton,	–	–	7	Not in operation, grind charcoal for foundry facings.

River-Statistics, Mills, Factories, etc., of the Taunton Valley—Continued.

Name of Stream or Branch.	Letters corresponding with Letters on Map.	Description of Mill, Etc.	Location.	No. of Hands Employed.	No. of Spindles.	Head and Fall.	Quantities of Materials used per year, so far as known.
Brook,		Saw and Box Mill (Robinson, King & Co).	Taunton,	3	-	Feet. 7	
		Saw Mill (Dean Factory Pond),	Taunton,	3	-	20	Runs all the year.
Brooks entering Taunton River.		Grist Mill,	Middleborough,	-	-	-	
		Shingle Mill,	Middleborough,	-	-	-	
		Nail Factory (B. O. & C.),	Lakeville,	-	-	-	
		Tack Factory,	Bridgewater,	-	-	-	
		Saw Mill (Keith's),	Bridgewater,	-	-	-	
Namasket River,	V	Shingle Mill,	Middleborough,	-	-	-	
		Grist and Saw Mill,	Middleborough,	-	-	-	
		Grist and Saw Mill,	Middleborough,	-	-	-	
		Woolen Mill (Star),	Middleborough,	101	-	-	300,000 lbs. wool, 2,500 lbs. soda-ash, 33 tons logwood, 19 tons soap.
		Shovel Factory (Middleboro' Shovel Co.),	Middleborough,	30	-	9	3,120 doz. shovels made per year.
		Varnish Factory (Shavos),	Middleborough,	3	-	Steam.	2,080 bbls. japan, 780 bbls. varnish made.
Fall Brook,		Dam,	Middleborough,			17	No mill here now.

River-Statistics, Mills, Factories, etc., of the Taunton Valley—Continued.

NAME OF STREAM OR BRANCH.	Letters corresponding with Letters on Map.	DESCRIPTION OF MILL, ETC.	Location.	No. of Hands Employed.	No. of Spindles.	Head and Fall.	Quantities of Materials used per year, so far as known.
						Feet.	
Winetuxet River,		Cotton Mill (Jenkins Bros.),	Plympton,	14	-	12	140,400 lbs. cotton used per year.
Annasnappet Brook,		Saw Mill (Earl Sherman),	Plympton,	-	-	7	
Winetuxet Brook,		Grist and Saw Mill (Coles),	Carver,	3	-	10	
Stream entering Colchester Brook.		Saw Mill,	Halifax,	-	-	10	Not in operation. Dam not up.
Colchester Brook,		Box and Saw Mill (J. S. Bonney),	Plympton,	-	-	9	Not in operation.
Taunton River,	b¹	Paper Mill,	Bridgewater,	14	-	8	300 tons manilla paper made; 12 [illegible]boys sulph. acid used.
		Grist Mill,	Bridgewater,	2	-		
		Grist Mill,	Bridgewater,	2	-		
South Brook,		Box Factory,	Bridgewater,	-	-	12½	
Town River,	c¹	Bridgewater Iron Works,	Bridgewater,	550	-	-	5,000 tons scrap-iron, 500 tons pig-iron, 400 tons Swed. iron, 250 tons old iron, 6,000 tons coal, 624 carb. sulph. acid, 800 tons brass for tubes, 1,872 gals. mur. acid.
	d¹	Grist Mill (Oliver Ames & Sons),	W. Bridgewater,	2			

River-Statistics, Mills, Factories, etc., of the Taunton Valley—Concluded.

Name of Stream or Branch.	Letters corresponding with Letters on Map.	Description of Mill, Etc.	Location.	No. of Hands Employed.	No. of Spindles.	Head and Fall.	Quantities of Materials used per year, so far as known.
						Feet.	
Beaver Brook,	h^1	Saw Mill (J. A. Young),	E. Bridgewater,	3	–	19	Runs all the time.
		Hosiery Mill, Cotton and Woolen,	E. Bridgewater,	40	–	6½	100 bbls. soft soap. No wool cleaned here.
		Box Board Mill,	Abington,	–	–	–	
		Shingle Mill,	Abington,	–	–	12	
Matfield River,		Iron Works (Rogers & Sheldon),	E. Bridgewater,	65	–	18	2,500 tons iron made into nails, etc.
Salisbury Plain Riv.,		Saw Mill (S. D. Shaw),	E. Bridgewater,	–	–	12	
	i^1	Fertilizer Factory (Ward's),	W. Bridgewater,	–	–	6	Not doing much at present.
		Saw Mill (O. F. Curtis),	Brockton,	25	–	9	20,000 pairs lasts made per year.
		Last Factory (O. F. Curtis),	Brockton,				
		Last and Boot-Tree Factory,	Brockton,	7	–	8	
		Boot and Shoe Shop (Martin Wilde),	Brockton,	100	–	Steam.	
		Grist and Planing Mill,	Brockton,	–	–	–	
		Shoe Tool Factory,	Brockton,	–	–	8	
		Last Factory,	Brockton,	–	–	Also use	
		Shoe-String Factory,	Brockton,	–	–	Steam.	

Salisbury Plain Riv.,		Saw Mill (Marcus Leach), . . .	Brockton, . .	-	-	10½ also use Steam.	
		Shoe Shop (F. Packard), . . .	Brockton, . .	115	-		
		Shoe Shop (Lucius Leach), . . .	Brockton, . .	-	-		
		Grist Mill (F. F. Wheeler), . . .	Brockton, . .	-	-	8	
		Tack Works (W. W. Cross), . . .	Brockton, . .	10	-	6	
Satucket River, .		- - -	E. Bridgewater.				
Black Brook, . .		Saw Mill, ...	E. Bridgewater, .	-	-	-	
Br. of Poor Meadow River.		Tack Factory (small one), . . .	Hanson, . .	5	-	8½	
		Grist and Saw Mill, ...	Hanson, . .	-	-	9	Not in operation.
		Boot and Shoe Shop (Reed & Closson), .	Abington, . .	200	-	Steam.	10,000 cases boots and shoes made per year.
		Tack Factory (Brigham, Litchfield & Vining).	Abington, . .	50	-	Steam.	650 tons iron, 1 ton copper, 100 tons zinc, 5 tons steel, made into tacks and nails.
		Eyelet Factory (Dunbar & Rhodes), .	Abington, . .	-	-	Steam.	
		Box Factory (Atwood's), . . .	Abington, . .	-	-	Steam.	
		Tack Factory (Dunbar, Hobart & Whidden).	Abington, . .	300	-	11	2,250 tons tacks made; 600 carboys sulph. acid used.
Small streams, .	j[1]	Saw Mill, ...	Halifax, . .	-	-	-	
	k[1]	Saw Mill, ...	Hanson, . .	-	-	-	

River-Statistics, Taunton Valley, Summary.

	Number.	Operatives Employed.
Woolen Mills.	4	171
Cotton Mills, ...	10	1,419
Iron Works, ...	30	3,317
Paper Mills, ...	3	35
Silver-plating, Jewelry and Watchmakers, . .	4	615
Shoe-shops, ...	4	482
Laundry, ...	1	8
Fire-brick and Crucible Works, ...	3	39
Saw and Grist Mills, ...	87	-
	146	6,086

Mr. Fuller gives the following additional notes: —

"Of the height of the water, when samples were taken, I would say that I think the water was as low as it has been this summer. The season has not been a dry one, there having been frequent rains, and probably the river has not been so low as it generally is in the summer season.

"The Taunton Valley is not rocky. There is no limestone, and I think no quarries of any stone. A stone, called white stone, is found in the vicinity of Long Pond, in Freetown. It is used in making iron furnaces. Field bowlders of granite are met with.

"The common river and pond fish are found through the entire valley; viz., red and white perch, pickerel, shiners, flat-fish, horned pouts; in some of the ponds, bass have been placed. In the main river there are also, in the spring, herring. I do not think any fish have been driven off by the polluting refuse of mills or by the sewage of towns.

"Little or Three Mile River receives the polluting refuse of

There are, without doubt, some small beds in existence in the northern part of this town, and in Sharon, West Bridgewater, Mansfield, and other adjoining towns. The bottom of Massopoag Pond, in Sharon, being an ore-bed, the right to use the same, still belongs to the heirs of Gen. Leich, who at one time was the largest iron-man in the State, he running blast furnaces at Easton, Foxborough, Walpole and North Chelmsford. The fact of this being an iron region would account for the establishment of the iron-works in Bridgewater. But, as regards the iron-works in Taunton, I think that they were started as business investments, and not from the fact of the ore region, as in the case of the other establishments mentioned. Since 1835, the iron used here is obtained from other States; no iron being made from the ore since that time in any of the foundries I have mentioned."

Analysis of Statistics.

In the following table the statistics are condensed as before of some of the points on the streams from which samples of water were taken for analysis. The results of the analyses can here be compared with the measure of pollution.

In the second table will be found, grouped from Prof. Nichols' tables, the analyses of the waters taken from the points indicated in the one previous to it; the letters will show the positions of these points on the map. Several examples of the character of the head waters are also given.

TAUNTON RIVER VALLEY—*Condensed Statistics for a few of the Points from which Samples of Water were taken for analysis.*

NAME OF PLACES,	a Near North Dighton.	b On Three Mile River.	J On Mill River.	(B) t Taunton Riv. E. Taunton.	C	a On Wine-tuxet River.	b On Town River.
Drainage-area in square miles above points indicated,	447.	83.	47.	283.	177.	36.	137.
Dry-weather flow at respective points in 24 hours, cub. feet,	9,655,200	1,792,800	1,015,200	6,112,800	3,823,200	777,600	2,959,200
The same in U. S. gallons,	72,220,896	13,410,144	7,593,696	45,723,744	28,597,536	5,816,448	22,134,816
Number of polluting factories or mills above respective points,	59	17	14	20	17	1	16
Number of polluting factories or mills above respective points per square mile.	.13	.20	.29	.07	.10	.03	.11
Number of operatives in said mills,	6,401	687	2,624	2,419	1,963	14	1,949
Population in basin above respective points in 1875,	65,482	8,968	12,470	33,814	26,609	1,562	25,047
Population in basin per square mile,	144.5	108.0	265.3	119.5	150.3	43.4	182.8
Population of cities, villages, mills or works sewering into the river above said points.	12,200	1,450	4,600	4,150	3,750	50	3,700
Population of this character per square mile,	27.1	17.5	97.9	14.6	21.2	14.	27.0

Analysis of the Waters of the Taunton River.

[Parts in 100,000.]

Date.	Letters on Map.	Localities.	Ammonia.	"Albuminoid Ammonia."	Solid Residue.		Chlorine.	Oxygen required.
					Organic.	Total.		
Aug. 17, 1875,	n	Leaches Stream, above pollution,	.0043	.0171	2.16	4.56	0.28	0.815
" 17, 1875,	g	Ames Pond, above all pollution,	.0053	.0165	1.28	3.36	0.27	0.427
" 20, 1875,	k	Monponset Pond, above pollution,	.0133	.0171	2.36	4.76	0.44	0.196
" 5, 1875,	b'	On Town River or Upper Taunton,	.0075	.0211	-	6.16	0.31	1.608
" 5, 1875,	a	Winetuxet River,	.0091	.0229	3.80	7.64	0.46	-
July 30, 1875,	t	Taunton River, near East Taunton,	.0069	.0235	2.66	5.32	0.42	1.359
" 28, 1875,	q	Taunton River, near Taunton,	.0080	.0208	2.56	5.64	0.40	1.436
" 28, 1875,	j	On Mill River,	.0123	.0245	2.24	4.92	0.33	0.787
Aug. 4, 1875,	b	On Three Mile River,	.0080	.0181	1.96	4.40	0.32	0.713
" 4, 1875,	a	Taunton River, near North Dighton,	.0085	.0197	4.32	16.00	5.50	1.012

In the last example of this table, from water taken near North Dighton, there is evidence of some mixing of the salt water with the fresh. In the other examples, the water taken from Town River and from Winetuxet River, show larger proportions of solid residue than any of the others, except the last; and yet the pollutions to which those streams are exposed at these points are much less than for any of the other examples, and they could not be condemned now on that account. This river was not at its lowest dry-weather stage when the samples of water were taken for the chemist, nor has this stage been reached this season, so far as I can learn, upon this or any of the rivers examined by us.

Of the waters examined from this valley, Prof. Nichols remarks: —

"The waters of the great ponds (such as Assawampsett, Great Quittacas, Little Quittacas), and of some of the brooks at the head waters of the Taunton River, are clear and colorless. The water of the river itself, and of its main tributaries, is quite strongly colored with vegetable matter, probably in part at least combined with iron, which occurs to a greater amount in the waters of this stream than in that of some of the others examined.

"The waters, like those of most rivers, are slightly alkaline, less so as a rule than those of the Chicopee or Blackstone, and much less so than the Connecticut, at Springfield. On two occasions only have I observed other than an alkaline reaction. Samples of water were taken at two different times at East Taunton, above and below the Old Colony Iron Works. The sample taken August 6th, below the works, was slightly but distinctly acid. The other occasion was August 5th, when specimens were taken above and below the Bridgewater Iron Works. The specimen taken above the works was slightly alkaline; that taken below was neutral,—neither acid nor alkaline. This would seem to indicate that at times a small amount of acid liquor is allowed to run into the river.

"The only specimen polluted to any considerable extent was No. 39 (e on the map), taken below a wool-scouring establishment. This specimen was very turbid, and did not become clear on standing.

"The greasy-looking suspended matter was seen, under the microscope, to contain bits of animal hair (wool), and epithelial cells, besides animal and vegetable microscopic growth.

"The tables show that the influence of the salt water is felt above the entrance of Three Mile River, but not as far as the entrance of Little River (Mill River); also I think the tide has no influence on the water at 'Shallow Water,' from which point it is proposed to take the water-supply of the city of Taunton, the differences not following any regular law. I think the examination further shows that, while undoubtedly the most desirable water-supply for the city of Taunton is offered in the great ponds, yet the river is able to afford water sufficient and practically pure for domestic purposes, and superior to most, if not all, the water at present derived from wells."

In the accounts of the different valleys, one of the tables in each case presents among other data, what is there called the "dry-weather" flow of the stream, that the reader might understand something of the small volume of water which prevails in a low season of rainfall. The polluting refuse received into the particular stream may remain about the same per day for each month of the year, but, whereas its effect could not be perceptible during a flood, its proportion to the volume of water flowing down stream becomes greater and greater as the water gets lower, until, during its days of minimum water, it may, even when not otherwise excessive, foul the stream so as to render it unfit for any use then.

The dry-weather flow does not mean the minimum flow, which will sometimes not reach one-half of the other. The dry-weather flow is meant to represent the average of four to six weeks of the lowest stage of the river during an unusually dry summer. The dams and works on the river generally admit of this average being secured, and obliterate, so to say, the extreme minimum flow, which would in a natural state of the river-bed otherwise frequently be exhibited.

The following gaugings have guided me in deciding on the rates of flow assumed in these tables.

The Charles River, as gauged in August, September and October, 1845, by John B. Jervis and Walter P. Johnson,

gave an average of 19,108,451 U. S. gallons per diem through the month of September. The point chosen was above Newton Upper Falls, but below the Mother Brook. The Mother Brook draws off into the Neponset River, one-third of the water running in the Charles River. The natural flow per diem, for September, 1845, would therefore be 28,662,676 gallons. The drainage-area for this point is two hundred and thirty-six square miles; the flow per square mile therefore is 121,452 gallons per diem=16,235 cubic feet, giving a rate of 0.188 cubic feet per second per square mile.

Mr. Davis states that the flow of the Sudbury in the early part of November, 1874, as determined by accurate gauging, was 135,000 gallons per square mile of water-shed per diem. This is equal to 0.209 cubic feet per second per square mile.

The outlet of Flax Pond at Lynn was gauged by Mr. Fteley for Mr. Davis, from November 24 to December 13, 1874, at the height of the drought. The yield averaged 128,400 gallons per square mile of the water-shed, which is equal to 0.198 cubic feet per second per square mile.

The only gauging which I have of the Merrimack River shows a much larger rate of summer-flow. A note from Mr. James B. Francis gives me the following information: "A gauge made of the flow of the river here (Lowell), July 24 and 25, 1840, when it was called unusually low, gave 1,488.63 cubic feet per second. Another, during the same drought, "August 2 and 4, 1840, gave 1,505.91 cubic feet per second. This was before we had any control of the lakes and reservoirs."

The water-shed above this point is estimated at 3,598 square miles.

This gives a rate of 0.416 cubic feet per second, which is more than double of the gauging on the smaller streams given above. The lakes and reservoirs on this water-shed must have affected the result, although they were not utilized then for mill-power to the same extent as now.

The first three instances, as belonging more nearly to the grounds which have been examined this season, have been taken as a sufficient guide in this instance. The average of these is 0.198 cubic feet per second per square mile. I have taken it at 0.200 per second for the Chicopee River, the

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CONCLUSIONS.

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when he is prostrated by sickness and his powers of resistance to such influences are then proportionally impaired.

We have therefore, as Dr. Frankland says, always to ascertain and keep in view the character of the stream as regards exposure to pollution, and, if it has received much filth in its course, to consider its waters objectionable and to be avoided if possible for human use; unless, indeed, the volume of the stream should be so great, compared with the filth-pollution, as practically to be independent of such reasoning.

As an instance confirmatory of these remarks, take the water of the Blackstone River at the point where it crosses the state line, near Blackstone.

The river reaches this point, carrying with it the sewage of the city of Worcester, the refuse waters of thirty-six woolen mills, twenty-three cotton mills, six iron-works, a tannery and a slaughter-house,—these works employing 7,200 hands, much of whose ablutions and sewage passes into the river.

The sewage of Worcester may be taken at a minimum per day of	2,000,000	gals.
The sewage of the mill operators and their families, at	36,000	"
The fluid refuse of the mills it is difficult to estimate even approximately; it was estimated by the assistant engineer at 2,678,000 gallons—say, ...	2,500,000	"
Gallons per diem, ...	4,536,000	

Equal to 606,508 cubic feet per diem.

At Blackstone, the dry-weather flow of the river is taken at 5,961,600 cubic feet per diem.

This last includes the polluted waters as above estimated. We have therefore in this case, 5,355,092 cubic feet of unpolluted water mixed with 606,508 cubic feet of badly polluted water.

The sewage and refuse waters delivered into this river amount, then, by this estimate, to a little over ten per cent. of the average dry-weather flow of the stream at Blackstone,

a degree of contamination which will be admitted to be condemnatory of that water; but, when the sample of water was taken for analysis (July 10), the river was not at its lowest summer stage, which generally occurs much later in the season. The flow in the river was not gauged at the time that the sample was taken for analysis, but its rate at that time might probably be about double of the dry-weather flow of a low season of rainfall, which would reduce for that date the proportion of the Worcester and trades sewage to over five per cent. of the volume of water running at Blackstone.

None of the rivers examined by us have this season reached the low stage of water referred to; they have all been in a low summer stage when the samples of water were taken, but not exceptionally so; and yet this exceptionally low stage must be encountered, sometimes for months, during very dry years. The pollutions received must, then, be applied to this measure to understand the degree of foulness to which the stream will be subject, noting, however, that during the very dry stage referred to, while the pollution from sewage will not be reduced, the pollutions from trades refuse will be diminished considerably, whenever for want of water the factories are obliged to intermit or work half-time.

The analysis fails to show much difference between the water of the river at this point and its head waters—not enough to condemn the water for domestic use or any other use; but if you mix five per cent. of sewage-water with ninety-five per cent. of unpolluted river-water, the chemist could hardly fail, we should suppose, to discover some evidence of pollution. If this be so, we cannot avoid the inference, notwithstanding what has been said, and notwithstanding the opinions of eminent English chemists, that in the course of its movement over some twenty miles of the river channel, the sewage fluids in this case have lost some of their impurities, and that the analysis is not entirely at fault in encouraging this inference.

Of our rivers enough has been said, now and heretofore, to show that any defence of their waters against the impurities which so conveniently flow into them from the settlements and works on their banks, has thus far been merely nominal; that is, the law can be used to prevent a nuisance from con-

tinuing to be poured into the river, but it is not used because the process is too slow, cumbersome and expensive.

To change this state of affairs, and to remedy it radically, is the problem now presented; and, while those who have been obliged to study the subject are confident that it is not insoluble, it is full of that kind of difficulty to overcome which will demand great perseverance, some experimenting, and, it may be, considerable invention and ingenuity. Not that there has not been much done in Great Britain to give direction to whatever may have to be done here, but our severe winter climate presents a difficulty by itself which will require special treatment; and, while there appears to be nothing insurmountable in dealing with it, it will probably add to the expense of all the purifying processes necessary to meet the different kinds of pollution to be dealt with. Every process will have in some degree to be tentative on this account, until the simplest and most economical mode of meeting the case is reached.

The Prevention of Pollution.

The law requires the Board of Health "to devise a system by which said rivers, estuaries and ponds may be protected against pollution, so far as possible, all with the view to the preservation of the health of the inhabitants of this Commonwealth."

To devise and perfect a system as varied in its modes of action as the fluid impurities emanating from the different kinds of works and from ordinary sewage will require, must, as has been hinted above, be a work of time; and, while authority must be lodged somewhere to begin this work, and probably to expend some money in ascertaining sometimes how to begin, it seems obvious that the authority given, should, in fairness to cities and manufactories, be exercised in the first instance only conditionally, and that in the case of any fluid impurities requiring to be stopped from entering the stream and to have their poisonous qualities destroyed, and the residue rendered innoxious before being passed into the stream, the authority having the power to require this course should be required to show how it can be done, and the apparatus or material required to effect it. In other

words, that authority must be prepared to indicate or teach the mode of purification before taking legal action against it, the party required to act in the particular case being, however, at liberty to follow any process which he may prefer having in view the same end.

It may be further remarked in this relation, that the authority indicated should have the power to interfere with the pollution by steps, if advisable, perfecting such processes thereafter as circumstances admit of it. This might operate better than attempting that thoroughness of purification which may be practicable at once, inasmuch as entire purification will not probably in any case be attainable.

It may seem out of place in this paper to notice this phase of the subject, but its consideration is not easily avoided, and the allusion to it grows naturally out of the subject.

As an instance of the kind of difficulty which will have to be studied and overcome, the application of sewage to irrigation may be mentioned. Of all the modes of dealing with sewage, this may be said to be the favorite, inasmuch as it undertakes in a more simple way than any other to apply the fluid sewage upon land so as to make it as largely remunerative as possible. But there are two kinds of irrigation in this connection,—the irrigation which, whether using water or sewage, applies it to the crops only as required and in quantities calculated to produce the best results. This kind of irrigation may be said to be always profitable; but, in this case, what is not wanted is not purified, and the overplus of that which has been used is not purified, although it has been somewhat deprived of its noxious qualities.

The other kind of irrigation is that which has in view, not merely the utilization, but also the absolute purification of the sewage-water. In this case there must be, first, such a liberal extent of land provided as will admit of the sewage during the growing season, at least, being entirely used by the different crops, arranged to that end. The process of irrigation, to produce the best results, being always intermittent, the grounds are broken up into many divisions or plots (the circumstances prescribing their size and number), so that the sewage-fluids can be transferred at will from one plot to another, or from one kind of crop to another; and there

would want to be some idle plots, so to say, upon which the sewage could be thrown at seasons when it was in excess of what the growing or maturing crops required. The reader will understand that in the process of irrigation a certain portion of the fluid will settle into the ground; and it is desirable that the ground should be of such a free and open character as to admit of this and to encourage it; for it is this earthy filtration supplementing the action of roots of the growing crops which deprives the sewage of its noxious qualities, and renders what is left of it fit to escape into the neighboring brook or stream. If this character of ground is not present, if the irrigation field has a heavy or clayey soil, deep drainage will enable it to produce the same cleansing effects; but the ground must be high enough to admit of this drainage-water, thus purified, escaping freely into some neighboring stream. To this, the most favorable view of irrigation as a means of entire purification, there are two exceptions, and under a negligent manipulation of the process there would be more; these are, first, the storm waters, which at certain times will make the delivery through the sewers so large as to render any reasonable extent of irrigation-fields incompetent for the time being to meet the excess, which cannot be allowed to flood the field, but must be otherwise taken care of; the second exception is the winter, when for some months, it may be, the irrigation-fields will become useless as such. Beginning with what can be done, the difficulties which these exceptions present will gradually solve themselves, and it would be needless now to speculate upon the precise way in which this will be accomplished.

Dr. Folsom's report of how this has been met in Northern Europe will throw some light on the matter. When a beginning is made, however imperfectly, the necessities of the case will create the ambition to remedy what is amiss or incomplete, and some satisfactory solution of this difficult problem will in all probability follow.

It will be thought by some that in the winter the sewer-fluids might be passed into the stream without rendering its waters so objectionable as in summer; but the reverse is said to be the case: the gases which escape from the sewer-deposits in summer from over the entire surface of the stream

are sealed up in winter, so that by breaking a hole in the ice the bad odor is made perceptible by this kind of concentration in winter, when in summer the sense of smell does not reach it under ordinary circumstances. The winter water is therefore more dangerous than the summer water except that, there being generally more water flowing in the river then, the poisonous fluids entering it will be more diluted,

It is probably true that no process or combination of processes for the sufficient purification of sewage-waters has ever produced results which collectively made it remunerative; the precipitate collected by most of the patent processes will always sell for something for farming purposes, and where irrigation is used besides, crops will be large and have commanded good prices, but the adjuncts (whether of land for filtration or otherwise) necessary to destroy the whole of the filth more than eat up the profits. It is a great advantage and encouragement to be able to reduce the cost of this kind of purification; but to attain the desired result without any outlay, far less to make it a means of profit, is not, in the present state of our knowledge, to be expected.

The ground below Worcester is understood to be very favorably situated for irrigation, and the soil and subsoil to be of the right character as well for filtration. There will be a good opportunity, then, to deliver the Blackstone River from this its greatest concentration of pollution, and to experiment on the kinds of winter appliances that will be necessary in combination either with irrigation or filtration.

Drainage and Sewerage.

We come now to the second branch of the subject in the order in which it has been presented here, although in the discussion of the first it has been impossible to avoid touching on the second.

The law requires the Board of Health "to investigate the subject of the correct method of drainage and sewerage of the cities and towns of the Commonwealth, and to devise and report a system by which said cities and towns may be properly drained."

To devise a system which, within the compass of a report of this kind would be applicable in its details to all cities and

towns, would be impossible; every city or town must be the subject of a separate study by a competent engineer, founded on a correct and minute survey of the streets or ground to be drained or sewered, with correct levellings of the whole.

The law evidently did not intend this construction to be put upon it, but it may have expected that some general principles should be presented controlling this part of the subject. Such general principles will govern each case, but to prescribe any special mode of carrying them out might be burdensome where all the State is interested in the result. Some points, however, may be noticed that are independent of any particular working system, or common to all of them.

In Europe, the drainage of the subsoil by a separate provision of drains, apart from the usual system of sewers to carry off the house-refuse, has been advocated, and there may be places where from the character of the subsoil or the amount of water present in it, such a double system would be desirable; but it has not found favor in this country, nor are we aware that it has been anywhere found necessary; * the increased cost of any such double system, and the inconvenience to the streets growing out of its proper maintenance, would always be barriers to its adoption.

The proper drainage of the soil is always very important, but, except where the water is held up by a neighboring river or lake or by tide-water, the trenches made for the sewers in our cities evidently act more or less as blind drains to keep it down.

This drainage of the subsoil, following as it frequently does the construction of sewers, if obtained at all through that defective construction which admits of leakage *into* the sewers, will do no harm while that leakage is moderate in amount, and consists of subsoil water escaping *into* the sewers. But the engineer will note that the same defective construction would admit of leakage from the sewer into the subsoil, when the subsoil-water happened to get below the level of the sewer, and that in this case the evil following a leakage outward would be twofold: the subsoil would be rendered filthy and might infect the neighboring cellars, and the

* It has been used for some years in three towns of England.

fluid necessary to the flow of sewage-matters, if lost in this way, would lead to deposits within the sewers of the heavier matters, very objectionable there in every way.

For the continued and perfect action of the sewage, therefore, under all circumstances, the sewer should be so constructed as to be tight, and not leaky, unless the circumstances make the other course very clearly desirable. It is not difficult to make concrete sewers tight, if made with Portland cement concrete, or its equal; nor is it difficult, with proper attention to the joints, to make a pipe-sewer tight, nor a brick sewer, if the engineer is determined to have it so.

The neglect of deep-soil drainage in the country at farmhouses, isolated dwellings of any kind, or villages, must be the cause of more sickness than any defects in the condition of the waters used there. In cities, the sewer-drains, or trenches, which are always deep, to some extent take care of it, and, where they do not, the damp or wet cellars make the danger known, and show the necessity then of some separate provision to keep down the subsoil water. In those streets of a city which lie on a river bank, subject to floods, or upon the seaboard, as Boston, where the tides rise from eight to ten feet, both the drainage and the sewerage, as ordinarily provided for, are liable to serious interruption; in the first case, irregularly; in the second case, daily. To provide, if possible, for the uninterrupted flow of the sewage, is always important. It is very important that that flow should not at any time be brought to rest, because then the heavier portions will become deposited, and will accumulate and fester so as to generate the dangerous gases which belong to putrid sewage, but which in the case of fresh sewage are merely offensive. It is desirable always that the sewage generated in a city should leave the city on the same day, within twelve hours at most, and that it should never be retained long enough to become putrid. The drainage in such exceptional cases would be a more difficult matter, and it would probably be cheaper in most cases to keep all streets and dwellings situated well up above tidal influences, than to attempt to keep down the subsoil water. But the interruption of the sewage-flow is another matter; it leads to a filthy deposit growing with each day, and which cannot be removed by the

rate of original flow which would have kept it in motion to the pump-wells, and prevented its deposit. If it is allowed to subside and get firm, it can only be carried off thereafter at intervals by storm waters, or by flushing, or by manual labor; in either case after it has become very offensive. Under such a state of things, ventilation becomes very important. It is conceded that the impure air of sewers should rather be allowed by frequent shafts to escape into the street, than be driven into the houses, as it will be more or less, if no other *outlet* is provided for it.

Of the sewage proper, the Board of Health is required "to report how far said sewage may be utilized and disposed of."

The utilization of sewage by irrigation has already been dwelt upon, and the auxiliary works which may have possibly to accompany irrigation wherever the intention is as well to render the sewage-fluid, or its residues innocuous.

The utilization separately of the precipitates from sewage has been and is in many patent ways accomplished, but the fluids are not entirely deprived of their baneful qualities, and are reported to be unfit to pass into a river. None of these processes are remunerative when the other condition of rendering the fluid residue sufficiently pure as well as clear is insisted on. It is to be remarked of all these precipitates from sewage that, except when mixed with lime or some other equally valuable ingredients, they are all but worthless for manure. To make them salable for agricultural purposes, they must be enriched with foreign ingredients, without which the offensive solids of the sewage could not be got rid of.

The attempt is being made in some places on the continent of Europe, with a good deal of success, to keep separate the human excrements, and not allow them to enter the sewers, withdrawing them separately from the houses while fresh, and in various ways preparing them for agricultural use. It is obvious that if this could be accomplished, the kitchen fluids, the trades and the street refuse would be somewhat more easily and more willingly dealt with. The human refuse, although trifling in *degree*, compared with the mass of fluid which flows through a sewer, is yet sufficient to give it much of its offensive character, and to produce, when the sewers are neglected, many of the offensive odors and gases that are

believed to be dangerous to health. The separate mode of disposing of human excrement is, however, repugnant to our habits here, and therefore, both here and in Great Britain, the water-closets and the removal by water of all human refuse is greatly preferred.

The most successful modes of dealing with sewage at this date, as well as with other pollutions which at present are rendering the waters of our streams so objectionable, are explained in the separate report of Dr. Folsom, who has devoted the past season to an examination of such operations in Europe. When it shall be necessary to act, we have thus the benefit of a large and varied European experience. Much of it can doubtless be assimilated here, with such additions or modifications as will meet the rigor of our winter climate.

The following skeleton maps are submitted with this statement, showing the streams of the five valleys examined, and also the positions of the dams and factories on these streams, viz. :—

The Chicopee River Valley.
The Blackstone " "
The Neponset " "
The Charles " "
The Taunton " "

Also an index map, giving on a small scale the principal river-valleys in the State.

TABLES OF ANALYSES:

WITH REMARKS ON THE WATERS OF THE DIFFERENT VALLEYS.

By Prof. WM. RIPLEY NICHOLS.

CHEMICAL LABORATORY OF THE MASS. INSTITUTE OF TECHNOLOGY,
BOSTON, January, 1876.

JAMES P. KIRKWOOD, Esq.

DEAR SIR:—Allow me to present herewith the report of the chemical examinations of the various samples of water sent to me by your assistants.

As a rule, the waters were allowed to stand for some twelve hours, in order that any matter in suspension might be deposited. The clear water was then drawn off for the determination of the solid residue. The determinations of "ammonia," "albuminoid ammonia" and "oxygen required to oxidize organic matter," were made after the water had been filtered through filter-paper. Owing to the unavoidable irregularity of the delivery of the specimens by the various express companies, and to the occasional interruption by Sundays, it was impossible that the different samples should be examined at the same length of time after their collection.

WATER FROM THE CHICOPEE VALLEY.

[See Table I.]

All the specimens of water from the Chicopee Valley were somewhat alkaline, and no case was observed where any refuse of any acid character had been thrown into the streams in sufficient quantity to alter the alkaline character of the water.

All the specimens were more or less colored by vegetable matter in solution. All deposited, on standing, a slight sediment containing vegetable matter, partly in combination with iron. There was not enough sediment in any case to make its determination seem of any practical moment.

The samples from the Connecticut River (Nos. 11 and 12) were less strongly colored, and possessed a more marked alkaline reaction. They contained a larger proportion of mineral matter, as appears from the table.

Water from the Blackstone Valley.

[See Table II.]

The waters were all alkaline. As a rule, they were not as strongly colored as those from the Chicopee, Taunton, etc. The samples taken from the upper part of the river showed evidence of considerable sewage-contamination. Some of them contained a marked amount of suspended matter, which amount was determined in a few cases. A disagreeable odor was also perceptible in some of the specimens.

Water from the Neponset Valley.

The results of the chemical examination are presented in Table III.

The waters are all slightly alkaline, are somewhat colored, and deposit a trifling sediment when allowed to stand quietly.

Water from the Taunton Valley.

[See Table IV.]

The water of the great ponds (such as Assawampsett, Great Quittacas and Little Quittacas), and of some of the brooks at the head-waters of the Taunton River, is clear, and nearly colorless. The water of the river itself and of its main tributaries is quite strongly colored with vegetable matter, probably, in part, at least, combined with iron, which occurs to a greater amount in the waters of this stream than in that of some of the others examined.

The waters, like those of most rivers, are slightly alkaline, less so as a rule than those of the Chicopee or Blackstone, and much less so than the Connecticut, at Springfield. On two occasions only have I observed other than an alkaline reaction. Samples of water were taken at two different times at East Taunton, *above* and *below* the Old Colony Iron Works. The sample taken August 6, below the works, was slightly but distinctly *acid*. The other occasion was August

5, when specimens were taken above and below the Bridgewater Iron Works. The specimen taken *above* the works was slightly alkaline; that taken *below* was neutral—neither acid nor alkaline. This would seem to indicate that at times a small amount of acid liquor of some sort is allowed to run into the river.

The only specimen polluted to any considerable extent was No. 39, taken below a wool-scouring establishment. This specimen was very turbid, and did not become clear on standing. The greasy-looking suspended matter was seen under the microscope to contain bits of animal hair (wool) and epithelial cells, besides animal and vegetable microscopic growth. The tables show that the influence of the salt water is felt above the entrance of Three Mile River, but not so far as the entrance of Little River (Mill River); also, I think the tide has no influence on the water at "Shallow Water," from which point it is proposed to take the water-supply of the city of Taunton, the differences between samples taken at different states of the tide not following any regular law. I think the examination further shows that, while undoubtedly the most desirable water-supply for the city of Taunton is offered in the great ponds, yet the river is able to afford water sufficiently and practically pure for domestic purposes, and superior to most, if not all, the water at present derived from wells.

Water from the Charles River.

[See Table V.]

The waters presented no marked peculiarity. They contained only a trifling amount of matter in suspension, and were not colored to a great extent.

TABLE I.—*Analyses of Samples of Water from the Blackstone Valley, July and September, 1875.* Collected by E. K. CLARK.

[Results expressed in Parts per 100,000.]

	Number.	Date of Collection.	LOCALITY.	Date of Examination.	Ammonia.	"Albuminoid Ammonia."	Solid Residue. Inorganic.	Solid Residue. Organic and Volatile.	Solid Residue. Total at 212 deg. Fahr.	Chlorine.	Oxygen required to oxidize organic matter.	Letter on Map showing where sample was taken.	Name of water from which sample was taken.
a	1,	July 7, 4.30 P. M.,	Canal above Blackstone Mills, ...	July 10,	0.0093	0.0150	3.44	1.72	5.16	0.38	0.371	a	Blackstone River.
b	2,	July 7, 5 P. M.,	Below Blackstone Mills,	10,	0.0099	0.0139	3.16	1.64	4.80	0.38	0.438	b	" "
c	3,	July 8, 9.20 A. M.,	Below dam at Blackstone, ...	10,	0.0157	0.0163	3.20	1.40	4.60	0.36	0.356	c	" "
d	4,	July 8, 11.30 A. M.,	Below dam at Millville,	10,	0.0168	0.0181	3.28	1.36	4.64	0.38	0.331	d	" "
e	5,	July 8, 6.30 P. M.,	Blackstone River, below junc. with West Riv.,	12,	0.0048	0.0152	2.00	1.92	3.92	0.24	0.400	e	" "
f	6,	July 8, 7.30 P. M.,	Blackstone, near state line, ...	12,	0.0114	0.0128	2.68	1.72	4.40	0.32	0.326	f	" "
g	7,	July 9, 11.20 A. M.,	West River, in Upton, .	13,	0.0128	0.0160	2.24	1.72	3.96	0.22	0.429	g	West River.
h	8,	July 9, 4.30 P. M.,	West River, below Wheelock's Mills, .	13,	0.0088	0.0133	2.40	1.40	3.80	0.24	0.392	h	" "
i	9,	July 14, 4 P. M.,	Mumford R., near junc. with Blackstone, .	16,	0.0091	0.0128	2.08	1.28	3.36	0.22	0.333	i	Mumford River.
[illegible]	[illegible]	[illegible]	Below Rochdale Mills,	16,	0.0093	0.0155	3.20	1.88	5.08	0.48	0.279	j	Blackstone River.

k 11,	July 14, 10.45 A. M.,	Blackstone River, below Farnumsville, . .	17,	0.0155	0.0160	4.24	2.36	6.60	0.54	0.326	k	Blackstone River.
l 12,	July 14, 12 M.,	Blackstone River, below Fisher's Mill, . .	17,	0.0112	0.0173	3.68	2.16	5.84	0.54	0.299	l	" "
13,	July 19, 11 A. M.,	Same as No. 12, . .	20,	0.0128	0.0160	4.12	2.08	6.20	0.50	0.321	l	Blackstone River.
m 14,	July 19, 11.40 A. M.,	Quinsigamond R., ¼ mile above junction, . .	20,	0.0053	0.0155	1.60	2.20	3.80	0.18	0.318	m	Quinsigamond River.
n 15,	July 19,	Trench below Simpson's Mill, on Blackstone R.,[3]	22,	0.0293	0.0181	4.64	2.56	7.20	0.74	0.439	n	Blackstone River.
o 16,	July 20, 10.10 A. M.,	Above Millbury cotton mill,[3]	22,	0.0560	0.0299	5.40	2.96	8.36	0.92	0.467	o	" "
18,	July 21, 2 P. M.,	Same,[3]	22,	0.0325	0.0327	4.92	2.96	7.88	0.66	0.470	o	" "
23,	July 22, 2.45 P. M.,	Same,[3]	23,	0.0288	0.0303	4.12	2.68	6.80	0.66	0.520	o	" "
27,	July 29, 9.30 A. M.,	Same,[3]	31,	0.0197	0.0213	4.88	2.40	7.28	0.74	-	o	" "
p 17,	July 20,	Morse's Sash and Blind Factory on Blackstone River,[2] . . .	22,	0.0992	0.0307	4.84	3.20	8.04	0.92	0.429	p	" "
24,	July 22, 3 P. M.,	Same, ...	23,	0.0661	0.0272	4.56	2.32	6.88	0.72	0.518	p	" "
29,	July 29,	Same, ...	31,	0.0597	0.0272	4.64	2.12	6.76	0.72	0.527	p	" "
q 19,	July 21, 2 P. M.,	Blackstone R., ¼ mile below Burling Mills,[4] .	22,	0.0640	0.0224	4.18	2.92	7.00	0.68	0.453	q	" "
r 20,	July 21,	Stone Bridge, below Quinsigamond Vill.,[5] .	22,	0.0672	0.0256	3.96	2.84	6.80	0.66	0.438	r	" "

[1] Rather more suspended matter than in Nos. 1-9.
[2] Some odor.
[3] Develops bad odor on standing.
[4] More iron apparently than in the preceding specimens. Considerable suspended matter.
[5] Suspended matter: Inorganic, 1.19; organic, 0.23; total, 1.42. Considerable iron in residue.

Analyses of Samples of Water from the Blackstone Valley — Continued.

Number.	Date of Collection.	LOCALITY.	Date of Examination.	Ammonia.	"Albuminoid Ammonia."	Solid Residue. Inorganic.	Solid Residue. Organic and Volatile.	Solid Residue. Total at 212 deg. Fahr.	Chlorine.	Oxygen required to oxidize organic matter.	Letter on Map showing where sample was taken.	Name of water from which sample was taken.
s 21,	July 22, 9.30 A. M.,	Just above Quinsigam'd Iron Works, Worces'r,[1]	July 23,	0 1866	0.0320	6.72	3.52	10.24	1.36	0.549	s	Blackstone River.
t 22,	July 22,	Singletary Stream, near Blackstone River,[2] .	23,	0.0107	0.0299	3.20	3.56	6.76	0.22	0 544	t	Singletary Stream.
28,	July 29,	Same, ...	31,	0 0149	0.0309	3.32	3.00	6.32	0.26	0 568	t	" "
u 25,	July 21, 12.30 P. M.,	Kettle Brook at Thayer's Mill, ...	22,	0.0149	0.0181	1.52	1.56	3.08	0.16	0.406	u	Kettle Brook.
v 26,	July 21, 5.30 P. M.,	Mill Brook above Washburn & Moen Manuf. Co.'s Works, . .	22,	0.0123	0.0181	2.60	1 32	3.92	0.24	0.416	v	Mill Brook.
w 31,	July 29, 11 A. M.,	Trench leading to Burling Mills, . . .	31,	0.0768	0.0283	4.36	1.92	6.28	0.64	0 490	w	Blackstone River.
x 32,	July 29,	Mill Brook, near Blackstone River,[3] . .	31,	0.9600	0.1109	18.48	4.96	23 44	3.80	1.098	x	Mill Brook.
y 33,	–	– –[4]	–	–	–	–	–	–	–	–	y	Kettle Brook.
34,	?	Blackstone River, above dam of Uxbridge Woolen Mill, . .	Aug. 11,	0.0075	0.0160	3.72	2.12	5.84	0.60	0.386	z	Blackstone River.
		Trench below Fisher's	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	" "

42,	Sept. 10, 6.30 P. M.,	Weasel Brook, one mile above North Pond, .	Sept. 15,	0.0067	0.0200	3.32	1.68	5.00	0.14	0.418	c'	Weasel Brook.
43,	Sept. 10, 7 P. M.,	North Pond, . . .	14,	0.0107	0.0213	2.40	1.80	4.20	0.18	0.588	c''	North Pond.
44,	Sept. 11, 10.30 A. M.,	Bottomly Pond, . .	14,	0.0128	0.0280	1.88	1.56	3.44	0.16	0.698	c'''	Bottomly Pond.
45,	Sept. 11, 12 M.,	Tatnick Brook, above Sinclair's Mill, . .	14,	0.0091	0.0213	1.72	1.44	3.16	0.14	0.559	c''''	Tatnick Brook.
46,	Sept. 11, 2.30 P. M.,	Middle of Lake Quinsigamond, . . .	14,	0.0037	0.0157	2.28	1.56	3.84	0.14	0.304	d'	Quinsigamond Lake.
47,	Sept 14,	Lower part of Tatnick Brook, . . .	15,	0.0072	0.0187	2.56	1.68	4.24	0.20	0.354	d''	Tatnick Brook.
48,	Sept. 14, 3 P. M.,	Gate-house on Lynde Brook, City Reserv'r,	15,	0.0072	0.0235	1.80	1.96	3.76	0.12	0.504	d'''	Lynde Brook.
49,	Sept. 15, 9 A. M.,	Singletary Pond, . .	15,	0.0176	0.0181	2.00	1.16	3.16	0.16	0.193	d''''	Singletary Pond.
50,	Sept. 14, 10 A. M.,	Manchaug Pond, . .	15,	0.0080	0.0181	1.72	0.96	2.68	0.16	0.236	e'	Manchaug Pond.
51,	Sept. –,	Lower end of Douglas Reservoir (source of Mumford River), .	18,	0.0048	0.0149	1.36	0.88	2.24	0.14	0.323	e''	Douglas Reservoir.
52,	Sept. –,	Singletary Brook, near Blackstone R. (same as Nos. 22 and 28), .	18,	0.0123	0.0381	3.20	3.00	6.20	0.26	0.599	t	Singletary Brook.

[1] Suspended matter:—Inorganic, 0.75; organic, 0.62; total, 1.37. Odor of sewage. Considerable iron in residue.
[2] Slight odor. Somewhat turbid. Not colored yellow, as the water of the Blackstone is to some extent.
[3] Quite turbid. Foul odor. Suspended matter:—Inorganic, 1.80; organic, 2.95; total, 4.75.
[4] Demijohn broken in transit.

TABLE II.—*Analyses of Samples of Water from Neponset Valley, July and August, 1875.* Collected by C. D. WARD.

[Results expressed in Parts per 100,000.]

Number.	Date of Collection.	LOCALITY.	Date of Examination.	Ammonia.	"Albuminoid Ammonia."	Solid Residue. Inorganic.	Solid Residue. Organic and Volatile.	Solid Residue. Total at 212 deg. Fahr.	Chlorine.	Oxygen required to oxidize organic matter.	Letter on Map showing where sample was taken.	Name of water from which sample was taken.
1, .	July 27,	Between South Canton and Dedham, . .	July 31,	0.0080	0.0160	2.32	1.96	4.28	0.36	0.694	C	Neponset River.
15, .	August 6,	Same, ...	Aug. 9,	0.0085	0.0192	3.00	2.04	5.04	0.50	0.725	"	" "
2, .	July 27,	S. Dedham, at 1st bridge above ink-works, .	July 31,	0.0080	0.0165	3.16	1.88	5.04	0.39	0.648	c1	" "
16, .	August 6,	Same, ...	Aug. 9,	0.0075	0.0149	2.76	2.12	4.88	0.36	0.664	"	" "
3, .	July 28,	Walpole, at bridge on direct road to S. Dedham,	July 30,	0.0040	0.0261	3.08	2.48	5.56	0.42	0.752	c3	" "
17, .	August 6,	Same, ...	Aug. 9,	0.0052	0.0171	2.28	2.76	5.04	0.38	1.165	"	" "
4, .	July 28,	So. Walpole, above all pollution, . . .	July 30,	0.0091	0.0325	1.88	2.52	4.40	0.28	0.790	d	" "
18, .	August 6,	Same, ...	Aug. 9,	0.0085	0.0176	1.84	1.92	3.76	0.27	0.792	"	" "

5, .	July 29,	Milton Lower Mills, above Baker's dam, .	July 30,	0.0101	0.0181	2.88	2.28	5.16	0.44	0.666	A	Neponset River.
10, .	August 6,	Same, ...	Aug. 7,	0.0123	0.0160	3.40	2.16	5.56	0.48	0.668	"	" "
6, .	July 29,	Below Hyde Park, at R. R. bridge, B. H. & E. R. R., ...	July 30,	0.0107	0.0261	2.68	2.60	5.28	0.43	0.687	a[1]	" "
11, .	August 6,	Same, ...	Aug. 7,	0.0101	0.0155	2.88	2.40	5.28	0.48	0.664	"	" "
7, .	July 29,	Mother Brook, Hyde Park, 1st bridge above junc. with Neponset R.	July 30,	0.0181	0.0181	2.56	2.64	5.20	0.34	0.774	a[2]	Mother Brook.
12, .	August 6,	Same, ...	Aug. 9,	0.0133	0.0176	2.48	2.16	4.64	0.37	0.516	"	" "
8, .	July 29,	Neponset River, ⅛ mile above junction with Mother Brook, . .	July 30,	0.0091	0.0203	2.80	2.32	5.12	0.45	0.709	B	Neponset River.
13, .	August 6,	Same, ...	Aug. 9,	0.0080	0.0197	3.12	1.92	5.04	0.51	0.684	"	" "
9, .	July 29,	Above all mills on Mother Brook, . .	July 31,	0.0043	0.0155	2.44	1.84	4.28	0.32	0.565	a[3]	Mother Brook.
14, .	August 6,	Same, ...	Aug. 9,	0.0069	0.0171	2.52	1.88	4.40	0.34	0.513	"	" "

TABLE III.—*Analyses of Samples of Water from the Charles River Valley, August and October, 1875.*

[Results expressed in Parts per 100,000.]

Number.	Date of Collection.	LOCALITY.	Date of Examination.	Ammonia.	"Albuminoid Ammonia."	Solid Residue. Inorganic.	Solid Residue. Organic and Volatile.	Solid Residue. Total at 212 deg. Fahr.	Chlorine.	Oxygen required to oxidize organic matter.	Letter on Map showing where sample was taken.	Name of water from which sample was taken.
36,	Aug. 21, 11 A. M.,	Below Bellingham paper mill, Medway, .	Aug. 26,	0.0128	0.0229	2.72	2.32	5.04	0.40	0.635	a	Charles River.
37,	Aug. 24, 10.45 A. M.,	Medway Village, below grist and shoddy mill,	26,	0.0123	0.0235	3.24	2.88	6.12	0.51	0.845	b	" "
38,	Aug. 24, 2 P. M.,	Below Bellingham woolen mill, . . .	26,	0.0059	0.0299	3.20	3.00	6.20	0.35	0.990	c	" "
39,	Aug. 24,	Below paint mill, on Wauban Brook, . .	26,	0.0032	0.0155	2.68	2.20	4.88	0.24	0.410	d	Wauban Brook.
40,	Aug. 31,	Above Newton Upper Falls, ...	Sept. 1,	0.0080	0.0293	2.68	2.92	5.60	0.40	1.043	e	Charles River.
41,	Aug. 31, 2 P. M.,	At Dedham, above stone bridge, . . .	1,	0.0096	0.0328	2.72	2.72	5.44	0.36	0.868	f	" "
55,	Oct. 1, 3 P. M.,	East Holliston Pond, .	Oct. 4,	0.0083	0.0208	2.44	1.48	3.92	0.36	-	g	East Holliston Pond.[1]

56,	-	Cedar Swamp Pond, Milford,	4,	0.0080	0.0272	2.24	2.20	4.44	0.41	-	h	Cedar Swamp Pond.[1]
57,	Oct. 1, 10 A. M.,	Whiting Pond, Wrentham,	4,	0.0059	0.0107	2.16	0.84	3.00	0.28	-	i	Whiting Pond.[1]
58,	-	Reservoir, head of Stop River,	4,	0.0085	0.0091	2.80	0.96	3.76	0.28	-	j	Reservoir, head of Stop River.
59,	Oct. 1, 8 A. M.,	Charles River, below junction of Mill Riv.,	4,	0.0069	0.0187	3.16	1.48	4.64	0.48	-	k	Charles River.

[1] No pollution.

TABLE IV.—*Analyses of Samples of Water from the Chicopee Valley, July and August, 1875.* Collected by C. D. WARD.

[Results expressed in Parts per 100,000.]

Number.	Date of Collection.	LOCALITY.	Date of Examination.	Ammonia.	"Albuminoid Ammonia."	Solid Residue. Inorganic.	Solid Residue. Organic and Volatile.	Solid Residue. Total at 212 deg. Fahr.	Chlorine.	Oxygen required to oxidise organic matter.	Remarks.
^{2}C 1,	July 7, 9 A. M.,	Quaboag River, below West Warren, . .	July 9,	0.0133	0.0203	2.40	2.92	5.32	0.24	–	– –
19,	Aug. 7,	Same, ...	Aug. 10,	0.0059	0.0107	2.56	1.88	4.44	0.17	0.564	– –
c^{3} 17,	" 7,	Between E. Brookfield and Quaboag Pond, near the pond, . .	10,	0.0069	0.0139	1.92	2.00	3.92	0.16	0.660	– –
c^{1} 18,	" 7,	Quaboag River, above Warren, ...	10,	0.0080	0.0139	2.28	1.96	4.24	0.17	0.714	– –
d^{2} 2,	July 7, 3.10 P. M.,	Turkey Hill Brook, above Wire Village, Spencer,	July 9,	0.0120	0.0264	2.64	1.56	4.20	0.12	–	– –
16,	Aug. 7,	Same, ...	Aug. 10,	0.0123	0.0171	1.88	3.20	5.08	0.16	1.373	– –
^{1}C 3,	July 8, 10.15 A. M.,	Ware River, below Gilbertville, Hardwick, .	July 10,	0.0067	0.0197	2.20	2.48	4.68	0.14	–	– –
21,	Aug. 9,	Same, ...	Aug. 11,	0.0069	0.0181	1.92	2.56	4.48	0.15	1.062	– –

d¹ 4,	July 8, 1.15 P. M.,	Ware River, 500 feet below Barre Falls, .	July 10,	0.0080	0.0219	2.12	2.88	5.00	0.14	-	-	-
20,	Aug. 9,	Same, ...	Aug. 11,	0.0075	0.0227	2.76	2.96	5.72	0.16	1.606	-	-
d² 5,	July 9, 10 A. M.,	Middle Branch of Swift River, at North Dana Village, ...	July 12,	0.0080	0.0110	2.16	1.32	3.48	0.14	0.282	-	-
d² 13,	July 22,	Same, ...	24,	0.0053	0.0128	1.64	1.88	3.52	0.08	0.432	-	-
²C 6,	July 9, 12 M.,	Swift River, below Enfield, Hampshire Co.,	12,	0.0128	0.0160	2.40	2.04	4.44	0.12	0.542	-	-
14,	July 22,	Same, ...	24,	0.0093	0.0165	2.28	2.16	4.44	0.09	0.536	-	-
B 7,	July 9, 6 P. M.,	Chicopee R., ⅓ mile below Palmer Cotton Mills, Three Rivers, Palmer,	12,	0.0112	0.0144	2.24	2.20	4.44	0.14	0.514	-	-
15,	July 22,	Same, ...	24,	0.0064	0.0115	2.48	2.32	4.80	0.11	0.508	-	-
a¹ 8,	July 10, 9.15 A. M.,	Chicopee R., ½ mile below Chicopee Falls, . .	12	0.0091	0.0147	2.72	1.48	4.20	0.12	0.483	-	-
10,	July 21,	Same, ...	24,	0.0096	0.0128	3.32	2.32	5.64	0 14	0.462	-	-
A 9,	July 10, 10.15 A. M.,	Chicopee R., at dam of Dwight Manuf'g Co, Chicopee Centre, .	12,	0.0112	0.0155	3.00	2.08	5.08	0.12	0.498	-	-
11,	July 21,	Connecticut R., opposite upper part of Spring'ld,	24,	0.0085	0.0128	4.64	1.64	6.28	0.09	0.394	Taken 1-3 across from west bank.	
12,	July 21,	Same, ...	24,	0.0085	0.0139	4.44	1.68	6.12	0.09	0.393	Taken 1-3 across from east bank.	

TABLE V.—*Analyses of Samples of Water from the Taunton River Valley, July and August, 1875.* Collected by F. L. FULLER.

[Results expressed in Parts per 100,000.]

Number.	Date of Collection.	LOCALITY.	Date of Examination.	Ammonia.	"Albuminoid Ammonia."	Solid Residue. Inorganic.	Solid Residue. Organic and Volatile.	Solid Residue. Total at 212 deg. Fahr.	Chlorine.	Oxygen required to oxidize organic matter.	Letter on Map showing where sample was taken.	Name of water from which sample was taken.
1,	July 28, 6.30 A. M.,	Stream from Forge Pond, Raynham, .	July 29,	0.0059	0.0245	2.48	3.00	5.48	0.34	1.486	r	Dead Swamp Brook or Two Mile Riv.
2,	July 28, 11.20 A. M.,	Taunton River, just *below* junction with Little River, . .	29,	0.0067	0.0240	2.80	2.32	5.12	0.34	0.998	i_1	Taunton River.
6,	July 28, 6.15 P. M.,	Same, ...	30,	0.0203	0.0181	2.84	2.16	5.00	0.35	1.050	i_2	" "
3,	July 28, 11.40 A. M.,	Little (or Mill) River, just before joining Taunton River, . .	29,	0.0123	0.0245	2.68	2.24	4.92	0.33	0.787	j_1	Little (or Mill) Riv.
34,	Aug. 10, 5.10 P. M.,		Aug. 14,	0.0176	0.0176	2.68	3.20	5.88	0.37	0.878	j_2	" " "
35,	Aug. 11, 11.15 A. M.,		14,	0.0091	0.0171	2.20	2.68	4.88	0.33	0.783	j_3	" " "*
4,	July 28, 11.50 A. M.,	Taunton River, just *above* junction with Little (or Mill) Riv.,	July 29,	0.0043	0.0235	2.44	2.92	5.36	0.39	1.124	o_1	Taunton River.
7,	July 28, 6.40 P. M.,		30,	0.0096	0.0197	2.68	2.72	5.40	0.39	1.349	o_2	" "

5,	July 28, 5.30 P. M.,	Taunton River, at "Shallow Water," taken at high tide, . . .	July 30,	0.0080	0.0208	3.08	2.56	5.64	0.40	1.438	q_1	Taunton River.
33,	Aug. 10, 4.20 P. M.,		Aug. 14,	0.0085	0.0197	2.56	4.24	6.80	0.38	1.680	q_2	" "
T 1,	April,		Apr. 23,	0.0067	0.0363	1.32	2.20	3.52	0.35	–		" "*
		Mean of last three, .	.	0.0077	0.0256	2.32	3.00	5.32	0.38	1.559		
13,	July 30, 4.15 P. M.,	Taunton River, at "Shallow Water," taken at low tide, . . .	Aug. 2,	0.0048	0.0192	2.88	2.56	5.44	0.40	1.460	q_3	Taunton River.
32,	Aug. 10, 11.25 A. M.,		14,	0.0085	0.0181	2.32	3.92	6.24	0.40	1.714	q_4	" "
T 15,	May,		May 4,	0.0007	0.0180	2.53	2.04	4.57	0.42	–		" "*
		Mean of last three, .		0.0047	0.0184	2.58	2.84	5.42	0.41	1.587		
8,	July 29, 9.50 A. M.,	Little River, above dam of D. C. M. Mfg. Co.,	July 30,	0.0176	0.0176	2.84	1.68	4.52	0.27	0.902	k	Little (or Mill) Riv.
9,	July 29, 10.45 A. M.,	Scadding's Pond, . .	30,	0.0091	0.0192	1.64	1.68	3.32	0.26	0.937	l	Scadding's Pond.
10,	July 29, 11.20 A. M.,	Prospect Pond, . .	30,	0.0112	0.0165	1.76	3.00	4.76	0.32	0.885	s	Prospect Pond.

* This determination was made for the city of Taunton.

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Analyses of Samples of Water from the Taunton River Valley — Continued.

Number.	Date of Collection.	LOCALITY.	Date of Examination.	Ammonia.	"Albuminoid Ammonia."	Solid Residue. Inorganic.	Solid Residue. Organic and Volatile.	Solid Residue. Total at 212 deg. Fahr.	Chlorine.	Oxygen required to oxidize organic matter.	Letter on Map showing where sample was taken.	Name of water from which sample was taken.
11,	July 30, 11.30 A. M.,	East Taunton, above Old Col. Iron Works, .	Aug. 2,	0.0053	0.0203	2.40	2.64	5.04	0.38	1.323	u_1	Taunton River.
27,	Aug. 6, 10.50 A. M.,		11,	0.0069	0.0171	2.80	2.36	5.16	0.40	1.228	u_2	" "
		Mean of last two, .	.	0.0061	0.0187	2.60	2.50	5.10	0.39	1.276		
12,	July 30, 11.50 A. M.,	East Taunton, below Old Col. Iron Works, .	Aug. 2,	0.0069	0.0235	2.76	2.56	5.32	0.42	1.359	t_1	Taunton River.
26,	Aug. 6, 10 A. M.,		9,	0.0080	0.0187	2.76	2.24	5.00	0.44	1.074	t_2	" "
		Mean of last two, .	.	0.0075	0.0211	2.76	2.40	5.16	0.43	1.216		
14,	July 31, 7 A. M.,	Taunton River at upper br. O. C. & N. R. R., .	Aug. 2,	0.0053	0.0175	2.76	2.64	5.40	0.40	1.420	p	Taunton River.*
15,	Aug. 4, 10.45 A. M.,	Three Mile River, just before it joins the Taunton, . . .	6,	0.0080	0.0181	2.44	1.96	4.40	0.32	0.713	b	Three-mile River.†

16,	Aug. 4, 11 A. M.,	Taunton River, 700 feet above entrance of Three Mile River, .	6,	0.0085	0.0160	4.28	2.44	6.72	1.06	1.004	h	Taunton River †
17,	Aug. 4, 11.15 A. M.,	Taunton River, 600 feet below junction with Three Mile River, .	6,	0.0085	0.0197	11.68	4.32	16.90	5.50	1.012	a	Taunton River.†
18,	Aug. 4, 2.35 P. M.,	Three Mile River, below Oakland Cotton Mill,	6,	0.0064	0.0187	2.88	2.20	5.08	0.26	0.963	c	Three Mile River.
19,	Aug. 4, 4 P. M.,	Three Mile River, above Crocker's Dam, Norton, ...	6,	0.0085	0.0181	2.16	1.84	4.00	0.26	0.785	d	Three Mile River.
20,	Aug. 5, 12 M.,	Nippenicket Pond, .	7,	0.0096	0.0240	2.52	2.80	5.32	0.28	1.369	e¹	Nippenicket Pond.
21,	Aug. 5, 2 P. M.,	Town R., *above* Bridgewater Iron Works, .	7,	0.0096	0.0224	2.88	3.20	6.08	0.30	1.533	d¹	Town River.
22,	Aug. 5, 2.20 P. M.,	Town R., *below* the iron-works, . . .	7,	0.0075	0.0211	* -	-	6.16	0.31	1.608	c¹	" "
23,	Aug. 5, 4.40 P. M.,	Taunton River, below Bridgew'r Paper Mill,	7,	0.0123	0.0203	2.96	3.08	6.04	0.45	1.375	b¹	Taunton River.
24,	Aug. 5, 5.40 P. M.,	Winetuxet R., Thompson's Bridge, . .	7,	0.0091	0.0229	3.84	3.80	7.64	0.46	-	a¹	Winetuxet River.

* Tide running up.

† High water.

Analyses of Samples of Water from the Taunton River Valley — Concluded.

Number.	Date of Collection.	LOCALITY.	Date of Examination.	Ammonia.	"Albuminoid Ammonia."	Solid Residue. Inorganic.	Solid Residue. Organic and Volatile.	Solid Residue. Total at 212 deg. Fahr.	Chlorine.	Oxygen required to oxidize organic matter.	Letter on Map showing where sample was taken.	Name of water from which sample was taken.
25,	Aug. 5, 6 P. M.,	Namasket R., just before it joins the Taunton, .	Aug. 7,	0.0058	0.0144	2.24	2.24	4.48	0.39	0.961	v	Namasket River.
28,	Aug. 6, 1.10 P. M.,	Assowompset Pond, .	11,	0.0059	0.0128	1.72	1.28	3.00	0.37	0.536	w	Assowompset Pond.
29,	Aug. 6, 1.30 P. M.,	Stream connecting Long & Assowompset ponds,	11,	0.0064	0.0155	1.84	1.68	3.52	0.36	0.824	x	Stream from Long to Assowomp't ponds.
30,	Aug. 6, 2.40 P. M.,	Little Quittacas Pond, .	11,	0.0064	0.0096	1.76	1.24	3.00	0.39	0.440	z	Little Quittacas Pond.
31,	Aug. 6, 4.15 P. M,	Great Quittacas Pond, .	11,	0.0069	0.0133	1.96	1.44	3.40	0.40	0.577	y	Great Quittacas Pond.
36,	Aug. 13, 4 P. M.,	Rumford River, Spring Street, Foxborough, .	24,	0.0139	0.0133	2.24	2.04	4.28	0.24	0.705	f	Rumford River.
37,	Aug. 13, 6.15 P. M,	Canoe River, Willow Street, Foxborough, .	24,	0.0155	0.0283	2.76	3.60	6.36	0.39	1.931	m	Canoe River.

38,	Aug. 13, 6.30 P. M.,	Billings Brook, Cocasset Street, Foxborough, .	Aug. 24,	0.0069	0.0080	2.24	1.24	3.48	0.26	0.423	g	Billings Brook.
39,	Aug. 23, 9.30 A. M.,	Rumford R., below Norton wool scour'g mill,*	24,	0.0144	0.0293	3.80	5.48	9.28	0.39	0.970	e	Rumford River.
40,	Aug. 17, 12 M.,	Ames Pond, No. Easton,	19,	0.0053	0.0165	2.08	1.28	3.36	0.27	0.427	g¹	Ames Pond.
41,	Aug. 17, 4.15 P. M.,	Massapoag Pond, . .	19,	0.0064	0.0144	1.36	2.28	3.64	0.27	0.388	–	In Neponset R. Val.
42,	Aug. 17, 5.10 P. M.,	Stream from Leaches Pond, ...	19,	0.0043	0.0171	2.40	2.16	4.56	0.28	0.815	n	Leaches Stream.
43,	Aug. 18, 7.20 A. M.,	Shovel Shop Pond, No. Easton, . . .	19,	0.0080	0.0139	2.60	1.60	4.20	0 28	0.336	f¹	Shovel Shop Pond.
44,	Aug. 19, 12.30 P. M.,	Beaver Brook, above Young's dam, East Bridgewater, . .	23,	0.0155	0.0256	2.68	2.60	5.28	0.40	1.349	h¹	Beaver Brook.
45,	Aug. 19, 3.30 P. M.,	Salisbury Brook, below Brockton Village, .	23,	0.0155	0.0160	3.12	2.24	5.36	0.60	0.822	i¹	Salisbury Brook.
46,	Aug. 19, 5.50 P. M.,	Robbins Pond, E. Bridgewater, . . .	23,	0.0128	0.0176	2.64	2.92	5.56	0.42	1.893	j¹	Robbins Pond.
47,	Aug. 20, 1.45 P. M.,	Monponset Pond, Halifax, ...	23,	0.0133	0.0171	2.40	2.36	4.76	0.44	1.198	k¹	Monponset Pond.

* Suspended matter:—Inorganic, 4.37; organic, 5.97; total, 10.34.

METHODS OF ANALYSIS.

Total Solid Residue.—Except where the turbidity of the water rendered the determination of the suspended matter desirable, the waters were allowed to stand for from about twelve to eighteen hours, and the clear water taken for evaporation. The amount taken for evaporation was 250 c.c., and the residue was dried at 100° C. After ignition the residue was treated with an aqueous solution of carbonic acid, and again dried at 100°. This loss on ignition is tabulated, according to common custom, as "organic and volatile matter," and is due in the main to the destruction of organic matter; the results thus obtained being sufficiently accurate for practical purposes, except when the water contains a considerable amount of nitrates and chlorides. In the case of well-water, not much value attaches to this means of determining the amount of organic matter.

Ammonia and " Albuminoid Ammonia."—The ammonia existing ready formed in the water as free ammonia, or as carbonate, etc., is determined by distilling the water with carbonate of soda, and estimating the ammonia evolved, by means of Nessler's reagent. A subsequent treatment with a strongly alkaline solution of permanganate of potash, as suggested by Messrs. Wanklyn, Chapman and Smith, causes the liberation of an additional amount of ammonia which is tabulated as "albuminoid ammonia" as it comes from the decomposition of albumin, or of other nitrogenous organic matter in some sense allied to albumin.

Chlorine.—The chlorine was determined volumetrically by means of a standard solution of nitrate of silver.

Oxygen required to oxidize Organic Matter, etc.—For the determination of organic matter by means of permanganate of potash, various methods have been proposed. I do not regard any method as giving absolute results. The method I have employed is that of Kubel, but I should regard the figures as relative, simply,—as affording additional data for the comparison with each other of the waters examined by the same person. No correction is made for the trifling amount of the permanganate which is, in these cases, used up in oxidizing any ferrous compounds.

II.—THE WATER-SUPPLY, DRAINAGE AND SEWERAGE OF THE STATE, FROM THE SANITARY POINT OF VIEW.

By Frederick Winsor, M. D., of Winchester.

Introduction.

This investigation originated in the action taken at a meeting of the councillors of the Massachusetts Medical Society, held October 7, 1874, by which they referred the subject of a paper there read by Dr. R. Amory, of Brookline, (on "The Use of Running Streams as Sewers,") to a committee, consisting of Drs. Adams, Amory, Bowditch, Crowell, Hartwell and Hodgdon. At the next meeting of the councillors (February 3, 1875), this committee reported, recommending that a memorial to the general court be prepared in the name of the Massachusetts Medical Society, for the appointment of a commission to thoroughly investigate the subject. A resolution was passed adopting the recommendation. Such a memorial having been duly presented, the legislature passed a bill which, as finally amended, directed the State Board of Health to "investigate the subject of the correct method of drainage and sewerage of the cities and towns of the Commonwealth, especially with regard to the pollution of rivers," etc., etc.*

The special investigation, whose results will be given in the present paper, was undertaken in order to determine with as much accuracy as possible to what extent and where, the public health of Massachusetts is endangered by the pollution of air, water or soil from the escape into them of whatever comes under the head of sewage, including under this term, excrement, both solid and liquid, as well as the wet waste of dwellings and manufactories.

It will be taken for granted that the public knows that such sewage is poison, and not to be retained in the neighborhood of

* See the Act, page 8.

dwellings or workshops without great danger of breeding what are well termed filth-diseases, if taken into the human body through the lungs or the stomach, in the air we breathe or in the water we drink.

In order to obtain the necessary information, the State Board of Health issued the following circular, which was sent to each medical correspondent of the Board :—

COMMONWEALTH OF MASSACHUSETTS.

STATE BOARD OF HEALTH.

To the Medical Correspondent of the Board in ———.

DEAR SIR :—By a recent Act of the legislature, the State Board of Health is required to investigate the question of the use of running streams as sewers, etc., etc. The Board desire to make as complete a report as possible, and one which will be valuable for future reference, embracing articles by Dr. F. Winsor, on the "Sanitary Aspect of the Question"; by James P. Kirkwood, C. E., on "Sanitary Engineering as applied to our State"; and by the Secretary, on "Methods, etc., in use in Europe."

Considering the importance of the subject, it is hoped that correspondents will be kind enough to send full and early answers to our circulars.

I. Has your town (or city) introduced water; and, if so, from what source and with what effect, if any, on the health of the community?

II. (*a*) Have you any system of sewers?
(*b*) If so, is it satisfactory?
(*c*) Where is the sewage discharged, and with what result to the health of the community?

III. If no system of sewers, how is the sewage of families and of manufactories disposed of?
(*a*) About what proportion runs on to the surface?
(*b*) About what proportion runs into sink holes?
(*c*) About what proportion runs into cesspools?
(*d*) About what proportion runs under privies?
(*e*) About what proportion runs into ponds, brooks or rivers?

IV. Is such sewage often or strongly offensive?

V. Are wells or other sources of water-supply exposed to contamination from it?

VI. Have you any experience of disease or serious discomfort resulting from sewage?

VII. If any water-courses or ponds are used to receive sewage from manufactories or other sources in your town (or city), will you please give some account of them?
(*a*) As to pollution of drinking water.
(*b*) As to pollution of the atmosphere, either by emanations from the contaminated water, or from flats, docks, banks of streams, etc.
(*c*) As to the effect of converting small streams into covered sewers.
(*d*) Any other facts that may occur to you.

VIII. Have you in your town (or city), damp or wet cellars?
(*a*) If so, have you noticed any apparent effect on the occupants of the houses?

IX. Do you know of any case where the sewage of one town pollutes the air or the water of another? If so, please state circumstances.

X. Please suggest such improvements in the matter of sewerage as you consider important in your town, either as to manufactories or otherwise.

XI. Can you send water for analysis, if desired?

Dr. F. Winsor, of Winchester, has been commissioned by the Board to conduct this part of the investigation; and all replies should be addressed to him by the first of August, or sooner, if possible.

In behalf of the State Board of Health,
Very respectfully yours,
CHAS. F. FOLSOM, *Secretary.*

STATE HOUSE, June 1, 1875.

Answers were received from 188 cities and towns.

The same circular was sent to the city engineers of our largest ten cities, with the request that they would furnish answers to questions I, II, III, IV, V, VII, IX and X. Their answers supply much valuable information in addition to that received from the medical correspondents. There are in the Commonwealth 322 towns and 19 cities, comprising a population of 1,651,652. All the cities, and 169 towns, furnished replies. Their population amounts to 1,386,156, which is eighty-four per cent. of the whole.* A list of these towns, with their respective populations, follows:—

* The towns from which no replies have been received are most of them quite small. Only nine have a population exceeding 4,000.

Abington,	3,241	Enfield,	1,065
Amesbury,	5,987	Everett,	3,651
Amherst,	3,937	Fairhaven,	2,768
Andover,	5,097	Fall River,	45,340
Arlington,	3,906	Falmouth,	2,211
Ashburnham,	2,141	Fitchburg,	12,289
Ashby,	962	Florida,	572
Ashfield,	1,190	Foxborough,	3,168
Athol,	4,134	Gardner,	3,730
Attleborough,	9,224	Gloucester,	16,754
Barnstable,	4,302	Goshen,	349
Barre,	2,460	Gosnold,	115
Belchertown,	2,315	Grafton,	4,442
Belmont,	1,937	Granby,	812
Berkley,	781	Great Barrington,	4,385
Berlin,	987	Greenwich,	606
Beverly,	7,263	Groveland,	2,084
Blackstone,	4,640	Hadley,	2,125
Blandford,	964	Hardwick,	1,992
Boston,	341,919	Harvard,	1,304
Braintree,	4,156	Harwich,	3,355
Brewster,	1,219	Hatfield,	1,500
Bridgewater,	3,969	Haverhill,	14,628
Brimfield,	1,201	Heath,	545
Brockton,	10,578	Hingham,	4,654
Brookfield,	2,660	Holden,	2,180
Brookline,	6,675	Holyoke.	15,260
Cambridge,	47,838	Hopkinton,	4,503
Canton,	4,192	Hudson,	3,493
Chatham,	2,274	Huntington,	1,095
Chelsea,	20,695	Hyde Park,	6,316
Chester,	1,396	Ipswich,	3,674
Chicopee,	10,331	Kingston,	1,569
Clinton,	6,781	Lancaster,	1,957
Colrain,	1,699	Lawrence,	34,907
Concord,	2,676	Leicester,	2,770
Danvers,	6,024	Leominster,	5,201
Dennis,	3,369	Leverett,	831
Dover,	650	Lexington,	2,555
Dudley,	2,653	Littleton,	950
East Bridgewater,	2,808	Lowell,	49,677
Eastham,	639	Ludlow,	1,222
Easthampton,	3,964	Lunenburg,	1,153
Easton,	3,898	Lynn,	32,600

Malden,	10,843	Reading,	3,186
Mansfield,	2,656	Revere,	1,603
Marblehead,	7,677	Richmond,	1,141
Mattapoisett,	1,361	Rockport,	4,490
Medford,	6,627	Rowe,	661
Medway,	4,242	Rutland,	1,030
Middleborough,	5,023	Salem,	25,955
Middlefield,	603	Sandwich,	3,417
Milford,	9,818	Sheffield,	2,233
Millbury,	4,529	Shelburne,	1,590
Monson,	3,733	Sherborn,	999
Montague,	3,380	Shirley,	1,352
Monterey,	703	Shrewsbury,	1,524
Montgomery,	304	Shutesbury,	558
Mount Washington,	177	Somerset,	1,940
Nahant,	766	Somerville,	21,868
Nantucket,	3,201	South Hadley,	3,370
Natick,	7,419	South Scituate,	1,818
Needham,	4,548	Springfield,	31,053
New Bedford,	25,876	Stockbridge,	2,089
New Braintree,	603	Stoneham,	4,984
Newburyport,	13,323	Stoughton,	4,842
New Salem,	923	Sudbury,	1,177
Newton,	16,105	Sutton,	3,051
North Adams,	15,760	Swampscott,	2,128
Northampton,	11,108	Taunton,	20,429
North Andover,	2,981	Tewksbury,	1,997
Northborough,	1,398	Tisbury,	1,525
Northbridge,	4,030	Topsfield,	1,221
North Reading,	979	Tyringham,	517
Orange,	2,497	Upton,	2,125
Orleans,	1,373	Uxbridge,	3,029
Otis,	855	Wakefield,	5,349
Oxford,	2,938	Walpole,	2,290
Palmer,	4,572	Waltham,	9,945
Peabody,	866	Ware,	4,142
Pembroke,	1,399	Warren,	3,260
Pepperell,	1,924	Watertown,	5,099
Pittsfield,	12,267	Webster,	5,059
Plainfield,	481	Westborough,	5,140
Plymouth,	6,370	West Brookfield,	1,903
Quincy,	9,155	Westfield,	8,429
Randolph,	4,061	Westhampton,	556
Raynham,	1,687	West Newbury,	2,021

West Springfield,	3,739	Winchester,	3,099
West Stockbridge,	1,981	Winthrop,	663
Weymouth,	9,819	Woburn,	9,568
Wilbraham,	2,576	Worcester,	49,265
Williamsburg,	2,029	Worthington,	818
Wilmington,	879	Wrentham,	2,395

One hundred and fifty-three towns have failed to respond to the circulars.

Fifty-one of these have less than 1,000 inhabitants; 63 have between 1,000 and 2,000 inhabitants; 21 have between 2,000 and 3,000 inhabitants; 9 have between 3,000 and 4,000 inhabitants; 4 have between 4,000 and 5,000 inhabitants; 4 have between 5,000 and 6,000 inhabitants; 1 has between 8,000 and 9,000 inhabitants.

Excrement Removal.

Of all forms of filth the most dangerous, as well as the most offensive and most common, is fecal excrement. Cast off by the human economy as not only incapable of furnishing any support, but utterly unfit to be longer retained in contact with the living body, it is nevertheless stored in the near neighborhood of most dwellings and of very many wells throughout the Commonwealth. It lies beneath privies, or in the cesspools which receive the wash from water-closets, dissolving and oozing more or less rapidly into the surrounding soil, from which it sometimes finds its way into some neighboring well, sometimes rises in gaseous form to poison the air, sometimes lies stored and lurking to infect any dwelling whose cellar may be dug into its ambush-ground with "mysterious" unwholesomeness. If any portion of that which finds its way into drinking water came from a person suffering with typhoid fever, cholera, dysentery, or with certain forms of intestinal worms, it sows the specific seeds of those diseases in many new victims till they multiply themselves manifold. Investigations carried to the point of demonstration in England have shown that several severe and extensive epidemics of typhoid fever have originated in milk brought from many miles away in the country and infected with water, into which a most minute amount of typhoid *excreta* had been washed

from an adjacent and neglected privy. There is no means known of purifying excrement on a large scale except by the roots of growing vegetation, and it does not become us to be positive that even this method can be depended on to disinfect that which carries the specific poison of cholera or of certain parasites.

The only proper way to deal with excrement is *to carry it as fast and as far away from human dwellings as possible;* and without doubt the best way to effect this is by a complete system of water-carriage. But such a system must be thorough, or it will expose us to dangers in our very sleeping-rooms. The subtle and, to most persons, the unsuspected ways in which these dangers arise, as well as the means by which they may be avoided, will be fully discussed in another part of the present volume, and therefore do not require notice here.

But the great majority of dwellings cannot be furnished with water-closets, and must depend upon some form of privy. It therefore becomes a question of the greatest sanitary importance what form is to be preferred. The things to be sought are:

(*a.*) Ease and inoffensiveness in removing the excrement.

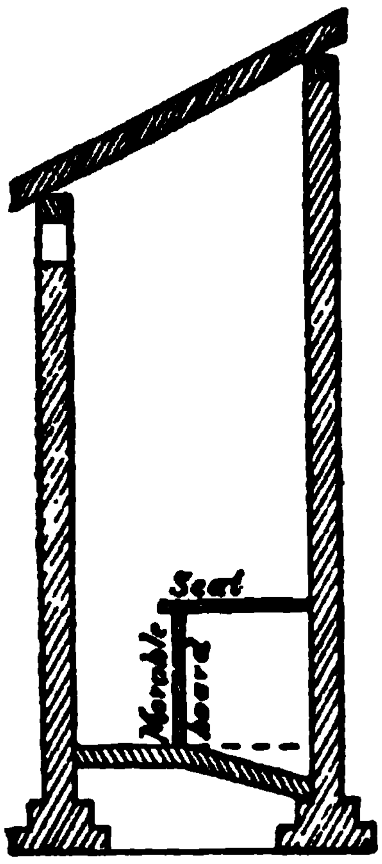
(*b.*) Security against its being absorbed by the material of the receptacle in which it is temporarily retained or by the adjacent soil.

(*c.*) Security against offence.

(*d.*) Economy.

In the second report of the medical officer of the Privy Council, England, 1874, is a paper by J. Netton Radcliffe on various ways of excrement-removal in use in Great Britain, which supplies a deal of valuable practical information, and from which several of the accompanying illustrations are borrowed. In all of them it will be observed that the receptacles are small, made of impervious material, easily emptied or removed, and cheap. It is the practice to add to their contents the family coal-ashes, either at every time of using or at short intervals. The largest is emptied as often as once a week, the smallest once a day. No "slops" from chamber or kitchen are allowed to be thrown in. By the adoption of some one of these methods several large towns and cities in

England and Scotland have rid themselves of most dangerous and disgusting nuisances in their most densely settled parts, substituting for them an arrangement at once more decent, cleanly, convenient and economical.



Hull Pattern (section).
Scale, 4 feet to an inch.

The privy used in Hull, here shown, is the simplest of all, and occupies the least space. The floor of the receptacle is of impervious material. Ashes and the dry refuse of the house are thrown down the seat, making with the excrement a dry, inoffensive mass, which is removed once a week with a spade, by removing the "movable board."

The Rochdale "pail-closet" system has been in use since 1868, and was thoroughly inspected and approved by Mr. Radcliffe in 1869. In 1874 he again inspected it, and gave it his unqualified approval. It consists of a closet (out of doors) of strong and simple construction, beneath the seat of which is placed a "pail" made from half a kerosene barrel, capable of holding one hundred pounds; but in fact the average weight of its contents after a week's use by an ordinary family proved to be forty-one pounds. This is removed weekly, and an empty and disinfected "pail" is substituted. In the case of very large families, or of workshops, the removal is made twice or thrice a week. At the time of removal, a tightly fitting metal lid is placed upon the pail. "The process of removal is quite inoffensive," and is *systematically performed.* The population of Rochdale in 1871 was 67,754; inhabited houses, 13,938; of which 2,944 were fitted with "pail-closets," used by 11,770 persons. In 1874 the number of houses so fitted was 7,287, used by 43,500 persons, when Mr. Radcliffe reported essentially as follows:—

That the system of removal had been thoroughly approved by all who had had experience of it; and that it had not failed under the most varied circumstances, having proved equally efficacious in the highly rented house with its own closet, in the lodging house where great numbers were accommodated, and in the factory and workshop.

The system includes removal of "dry dirt," too. This is sifted, and the fine ash is used in the process of manure manufacture; trenches are made in it, and the contents of the excrement-pails dumped there; more fine ash is placed above, and a quantity of sulphuric acid added to hasten drying. In five weeks the mass is pulverulent and inodorous.

In the finished manure there are eighty parts of excrement to thirty-five parts of fine coal-ash; twenty-five pounds of sulphuric acid are added to each ton.

Under the old midden (privy) system, in Rochdale, the cost of the removal of the excrement of one thousand persons for one year was £71. Under the "pail-closet" system, it was £19; the resulting manure selling for three-fourths of the cost of collecting and preparing it. The cost of a "pail" complete, was *4s. 9d.*

As to the working of the pail-system. The movableness of the pails is their great recommendation—the facility which the system gives for frequent, thorough removal, being enormous.

In this connection, it is impossible not to be struck with the advantage that a pail-system has in relation to diseased excrement. The facility and thoroughness with which any required chemical disinfection can be done, and the way in which the excrement itself can be wholly got rid of, leaving none of its products behind—nothing soaking into the ground, or hanging about midden-pits or sewers, obviously suggest most important powers possessed by this system for preventing the spread of excremental diseases.

In Manchester the use of dry coal-ash as a deodorizer is combined with a "pail-closet" system much like that of Rochdale. The receptacle for excrement is of galvanized iron, fifteen inches high, eighteen inches in diameter, and of a capacity of ten gallons. These are removed weekly for most families, twice or thrice a week for very large ones, fortnightly for very small and neat ones. This system had not been in operation two years when inspected by Mr. Radcliffe, but it received his approval, though not quite so unreservedly as that of Rochdale. The addition of dry coal-ash is an improvement, but the metal pail is inferior to the strong wooden one made from the kerosene barrel; and the sinking of the pit, in which the Manchester pail stands, below the surface of the ground, is

objectionable, as it makes removal more difficult. At the time of inspection the system had been applied to 6,000 of the 67,000 houses in Manchester, and was being extended at the rate of 5,000 houses annually. As at Rochdale, the removed excrement was composted into a marketable manure.

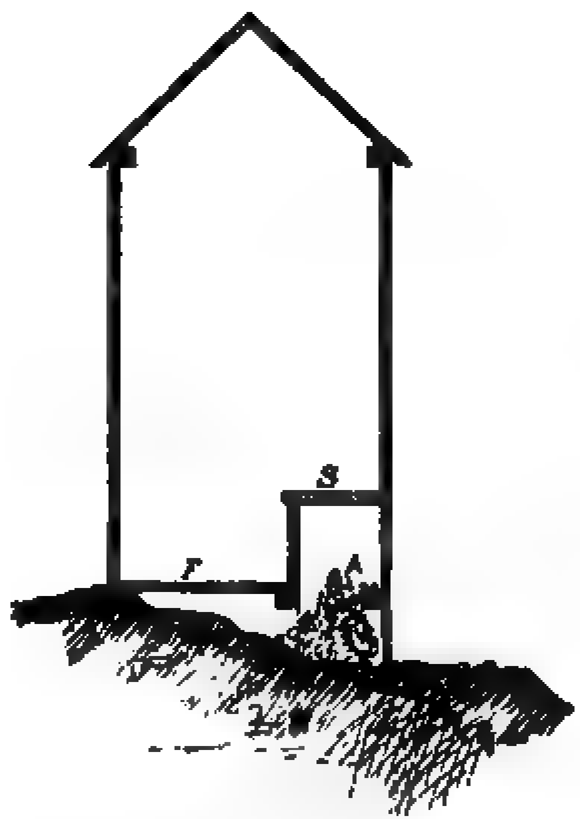
In all the pail-systems, some form of urine-conductor is used.

There would seem to be every reason why the law should require all factories, tenements and boarding-houses, not furnished with a satisfactory system of water-closets, to adopt some modification of this plan. At present many factories, whose operatives are numbered by scores and hundreds, have privies overhanging the streams which furnish power. This is *water-carriage* indeed! carrying, in many cases, the most dangerous and disgusting form of pollution to spoil the stream below.

The figure on page 185 shows a slight variation on one c the foregoing, which is occasionally seen in use in the Unite States, and seems on the whole preferable to any which tl writer has seen. There is no reason why any family, unpr vided with a water-closet, should not at once substitute c of the preceding apparatuses for its present privy. Suc change involves but little expense or trouble, and it wo put the matter of the disposal of fecal excrement on a foo altogether satisfactory, whether from a sanitary or a s point of view.

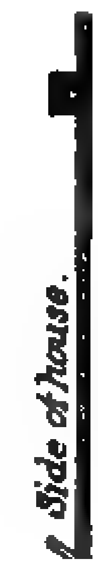
Every one admits that the methods now in almost univ use are anything but satisfactory; that most of then offensive, often disgusting. The diagrams here shown trate some forms very common in country towns, an manner in which they lead to the pollution of the surrou ground and of any well near them.

It may be said that the simplest and cheapest of those on the opposite page, one much in use in the smal try towns, involves the minimum of annoyance and ris whatever fecal accumulation occurs is all on the surfa is in such free communication with the outer air a rapidly dried and disinfected. But at the best it pol soil beneath more than is suspected. It is not cle one-tenth as often as is needed, and it exposes those



Section of common style of country privy on a slope
F. floor.
S. seat.
A excrement.
B leaching of fluids into soil.

Section of Privy with pit, and board sides



Common Sink-hole and spout
B.
C. sink hole in ground.
D Leaching from same.

it to the inclemencies of the weather to a dangerous extent; while for every form of privy which has any pit-receptacle—from a hole in the ground to a vault bricked and cemented—the sanitarian can have nothing but reprobation. Those that leak, as most do, pollute the ground; those that are tight,

PRIVY USED IN THE UNITED STATES.

A. Excrement tub. *B.* Tub of dry earth. *C.* Hinged portion of back of privy.

poison the air. The more they hold, the worse they are, because the older such undiluted wet filth is, the more dangerously poisonous is it.

It is amazing how blindly and recklessly this privy-poisoning of the ground is persisted in in many places. The strongest instance within the writer's knowledge is found in Three Rivers, Canada East, a town of about 6,000 inhabitants. There, with every natural facility for drainage and sewerage,

it has for two hundred years been the practice to m privy from one part of the house-lot to another, as the beneath its last resting-place became unendurably o Of course typhoid fever is endemic, *domiciled* in tha and medical skill struggles vainly with nastiness, as in every growing town which will not abandon the privy system.

It will be remarked that the methods here recon are, as it were, primitive forms of the earth-closet. have the advantage over it, not only in original ch but in simplicity, and in not claiming to be suited within the house walls. It is the general verdict who have watched the earth-closet, with the hop would make good its claims, that it is never a succe where managed with exceptional intelligence and vig qualification which makes it unavailable for the com large. How satisfactory it may prove, under prop tions, is admirably shown in the following extracts ters from Dr. R. S. Steuart, Medical Superintend Maryland Hospital for the Insane :—

"In 1852, our site was purchased, thirty-six acres. hundred feet above the harbor of the city of Baltimo land falls gradually to the water, six miles distant. O fronts to the east; the wings extend north and south 22 The drainage on either side follows a natural ravine. ravine on the north side is a fine stream made by the con thirteen good springs; this stream flows over a grani affords an abundant supply of good water, forced to th centre and wings into large tanks, holding fifty thousan water. This supply was freely used for bathing and closets, all constructed in the best manner and acting p must now state that the extensive area of land between tion and tide-water was almost uninhabited when our s chased in 1852.

"Many causes delayed the completion of our hospi and, during the twenty years' interval, many fine villas with the modern improvements for raising water for d poses; and from the owners of these we received in 1 the fact that several of the streamlets supplying them polluted by the drainage from our cesspools. Man were tried to remedy this, but all failed; we acknowlec

and agreed to pay damages according to circumstances, amounting to $3,000.

"We then, to avoid all future complaints, determined to adopt the earth or rather ash closets. These have been in operation eight months, and so far we hear no more complaints from our neighbors, far or near. We have organized a system by which the hods or buckets are removed twice or thrice a day, and carried to a con venient depot, where a compost is formed on our own grounds, pro ducing very little bad odor on the spot, and none at all at a dis tance of fifty feet; and we have the satisfaction to witness the good fertilizing effects of this compost on our fields and gardens.

"You also ask about the drainage of the water from the bath-tubs and from the kitchens. We have found that the water now discharged beyond our pipes does not indicate any signs of pollution, and is regarded to be as pure and available as the water from other streams in this section of the county."

In reply to further questions, Dr. Steuart wrote as follows:—

"December 4, 1875.

"My first plan was to have a large cesspool or well on each side of the hospital, twenty feet in diameter and twenty-five feet deep. Into these the drain-pipes, ten inches in diameter, flowed, taking all the flow from the house. I had presumed that the sinking of the contents into the earth would preclude all overflow. In this I was disappointed; the nature of the stratification below, in a few months, caused the accumulation to run out over our own grounds, and pass onwards. I then made other wells, three hundred yards off, to receive this flow, and, beyond these, filters were made of sand, gravel and charcoal. These second wells also overflowed; and although the fluid that passed off through the filter was clear and apparently innocent of all offensive matter, yet the smell was so offensive to our near neighbors as to make it necessary to abate this nuisance. These several experiments cost a great deal. To end the matter, the ash-closets were adopted.

The buckets are removed, morning and evening, and in some places three times a day. They are carried by private staircases, down to the basement, thence along these lower regions to an exit at the north wing, where they are emptied into a cart, constructed as the old-fashioned night-carts are; quite close, no leaking. The carts dump their contents at a convenient depot; stable-manure and some gypsum are added, so as to deaden the smell, and to improve the manure. It was the *overflow* our neighbors complained of.

"We have 220 patients and attendants, but only two of the latter, and a half-dozen of the paupers, are engaged in the removal of the buckets. Sometimes the agents in this dirty work complain of nausea; still I have no difficulty in getting men to do it. The only difficulty I have so far found is in the addition of too much liquid matter to the solids in the buckets. It should not be softer than mortar about to be used in brick buildings. If too liquid, the smell is intense. We have separate urine buckets."

Of course a system of removal must form a part of every plan of small unabsorbent receptacles; but this is so purely an executive matter as to need no discussion here. It is enough to say that such removal involves no annoyance to household or neighborhood; that it should be to some spot as distant as possible from inhabited buildings; that additional absorbents should be used at the place of deposit; and, finally, that the resulting compound should be applied at the earliest possible moment to growing crops, the only effectual means of disinfecting, on a large scale, such matters. The system is equally applicable to the small, isolated country house and to the crowded tenement house in the great city.

Where the present system of receptacle-vaults is persisted in, the local authorities should strictly prohibit the practice of emptying by the vile bucket and night-soil cart so long in use, and require that the work be done by some of the "odorless" machines now operating successfully in many cities, requiring also that the emptying should be done at much shorter intervals, to which the community will readily agree when they are satisfied that it can be done in one-tenth of the time and with one-hundredth part of the stench and outrage to decency which characterizes the method now in vogue, and which prevents any one from adopting it so long as it can possibly be deferred. Add to these advantages that of doing the emptying by the "odorless" process by day, and it only remains to show that it involves no more expense in order to insure its adoption wherever vaults and cesspools must be used.

There are several varieties of these "odorless" apparatuses, one of which can be obtained on the following terms: For a town of a population not exceeding 10,000, the right of use during ten years can be had for $300, and a complete set

of apparatus for $350 more. Thus equipped, any town, either by its own teams and workmen, or by contract, might thoroughly, inoffensively and quickly empty, by daylight, not only privy-vaults and cesspools, but "pond-holes," stagnant pools, etc. Odorless transportation, in manageable packages, forms part of the system, so that the matters removed can be offered, "in lots to suit purchasers," in the form of valuable fluid fertilizers. Surely a town making this investment could depend upon receiving in cash a sum sufficient to keep the apparatus in order and pay interest on the $650 expended.

There are various plans for the disposal of kitchen-sewage by overflow drains, in order to irrigate gardens and lawns, the receptacle tanks being emptied (or drawn down) automatically. These are excellent for climates milder than that of Massachusetts, but would require special protection from frost, which sometimes penetrates the ground to the depth of six feet and seriously interferes with such drainage for four months of the year. Yet we may hope to find some simple and effectual method of protection against cold, remembering that the temperature of sewage itself is ordinarily several degrees above freezing.

Next in importance to the question of excrement receptacles and removal is the question of cesspools and their emptying. To begin with, let us understand that the only proper way to make a cesspool is to make it as tight as possible, so that it cannot seriously pollute the soil without overflowing. A regard for health forbids our letting "sink-slops" and "chamber-slops" soak into the ground about a dwelling. They are sometimes poisonous, even at the moment they are discharged from the house, and are always quick to undergo decomposition and give off gases which are slow poison. Quick as these fluids are to undergo decomposition, they are slow to cease this process. They retain for weeks enough material to continue to generate their gaseous poison or to bear it in solution to wells and cisterns distant many feet and sometimes many rods; and then there is disease, if not death, in the cup we drink and the air we breathe. And all the while the earth about the cesspool is becoming more and more filled with filth, till it is saturated and incapable of straining out any more from the water that oozes into it.

Then, if it be a porous soil, the ooze from the cesspoo carry its filth farther and farther from the centre of pol If it be a retentive soil, it becomes "puddled," so as t the cesspool tight, in which case it soon overflows and the owner to make some attempt at sanitary reform. in the case of the cesspool which continues to let its c leach away. Every heavy rain, every spring thaw, a portion of the filth out of its bed in the soil into the well. For every well is the *drain* for the moisture c cumjacent region, which, at its minimum, correspon inverted cone, with its apex at the bottom of the w with a base on the surface of the ground at least as l the well is deep. This is shown by the diagram.

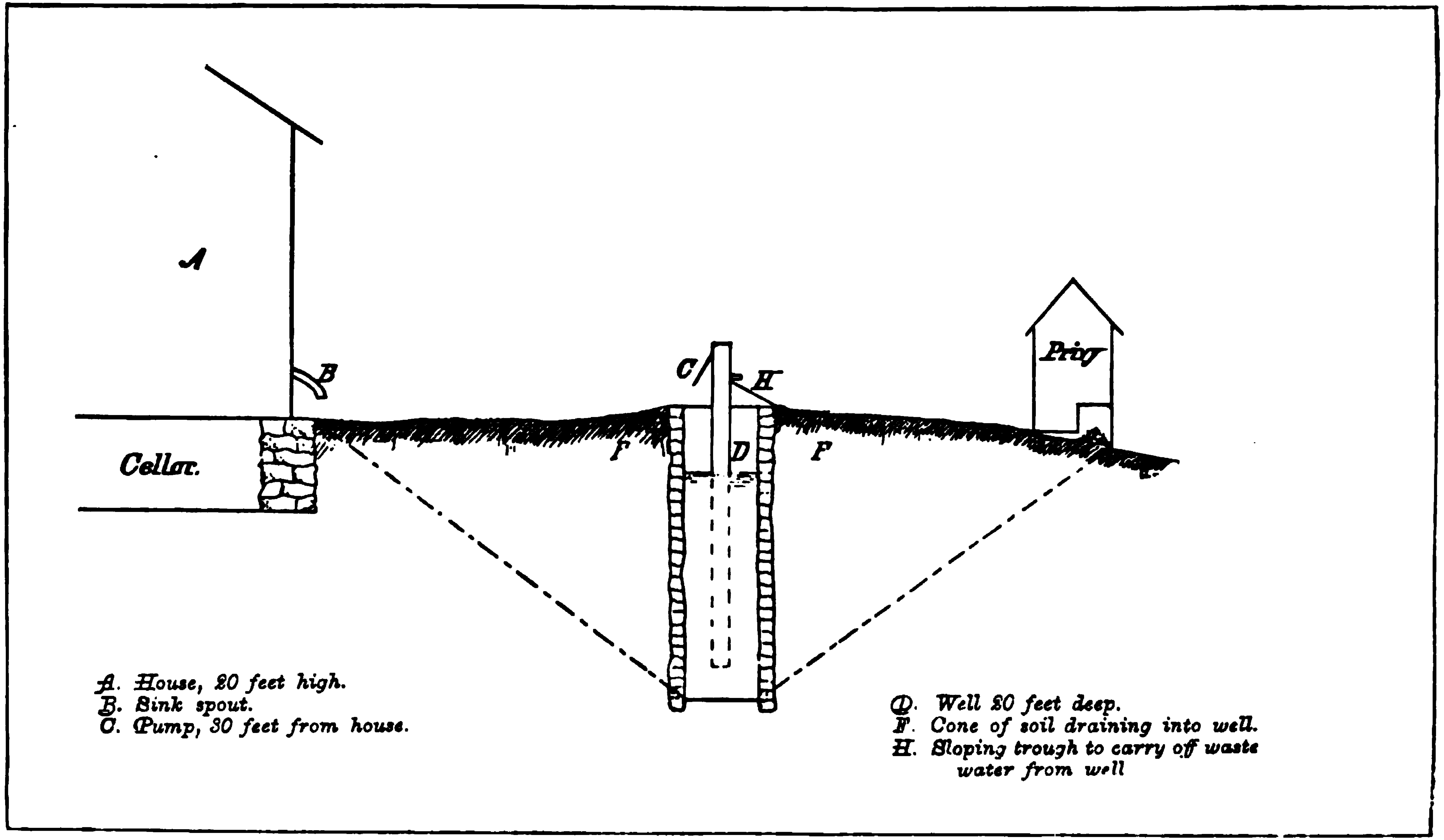
But most wells drain a much larger region, and if an impervious, inclined stratum or on a slope, th drain localities many rods distant. One has only to the case of a densely peopled hillside to realize the i pollution of wells from leaking cesspools or drains fa the slope.

The report of Mr. Child, officer of health for cer tricts in Oxfordshire, England, contains a striking in fouling of wells from a source above their level, been quoted by the "Medical Commission upon the Qualities of the Sudbury, Mystic, Shawshine and River Waters," in their report.* It is reproduced forcibly illustrating the danger in question:—

"In consequence of the escape of the contents of a petroleum or benzoline, which had been buried in an circuit of wells sixty feet below and 250 or 300 yards dist so affected that the occupiers of fifteen houses, contain two inhabitants, were for ten days unable to use the wate ing or cooking. The cattle of one of the proprietors, refused to drink at the spring where they were accustome Had this soakage been sewage instead of petroleum, wh that the result might have been wholesale water-poiso outbreak of typhoid fever?"

Now, it is a very moderate statement to say tha of ten cesspools, the State over, do leak, and are c

* City Document, No. 102. Boston, 1874.


A
B
Cellar.
C
H
D
F
F
Privy
A. House, 20 feet high.
B. Sink spout.
C. Pump, 30 feet from house.
D. Well 20 feet deep.
F. Cone of soil draining into well.
H. Sloping trough to carry off waste water from well

expressly to leak, and thus save the expense, labor and nuisance of frequent emptying. And it is obvious that as soon as any town obtains an abundant water-supply by aqueduct, its sewage is immensely increased (from six to ten or more times), so as to make the old method of drainage altogether inadequate to the new order of things. Yet, how many of the towns which have recently introduced water or have begun water-works, are providing any adequate system of drainage? The "water committees," or "commissioners," do not dare to tell the truth to the town, because of the great additional expense involved. They know that the necessity will become apparent in a few years after their water-supply goes into operation, and must then be met at an outlay much greater than would suffice if sewerage-works went side by side with laying of water-pipes.

In addition to the expense, there must arise the usually embarrassing question, Where shall be the outlet of the sewerage system, if it is undertaken? In the answering of this question, neighboring towns, as well as individuals, must be consulted, and vexatious and costly litigation may follow. This problem of the disposal of sewage, in which health and comfort are balanced against cost, is before many of our towns and cities to-day, and in the solution of it the smaller towns may be greatly helped by these odorless emptying machines. As was said under the head of excrement-removal, let it be obligatory on every householder to make his cesspool as tight* as possible, and to empty it by the new method alone, and the sanitary requirements may be met without incurring a great town debt and without wasting the sewage. Meanwhile, and also by the adoption, on suitable lots of land, of the plan of private irrigation by drain-tile, elsewhere suggested, valuable experience may be acquired to assist in solving the important question of irrigation on a large scale.

Water-Supply.

There are three forms of water-supply: wells, cisterns, aqueducts. Of these, the first has, of course, been that in

* The action of frost, the jarring of the earth from various causes, and imperfections in workmanship render it impossible, practically speaking, to keep cesspools *perfectly* tight.

general use in Massachusetts, as it must long continue to be in most towns not closely built up. To what forms of pollution it is exposed from privies, "sinks," cesspools, stables, etc., has been shown under a previous head. Whenever dwellings are within one hundred feet of each other, even on a level surface, there is danger that one may pollute the other's well through some one of the above-named agencies. It may quicken the reader's sense of this danger to construct a diagram of four houses, each within one hundred feet of the other three, to locate the privy, cesspool, stable, hen-house and well of each as these are ordinarily placed, and then, making another diagram, showing a vertical section of one of these wells, thirty feet deep, to study its possible action as a drain of the neighboring surface, especially in the case of dwellings so circumstanced for many years. Such a neighborhood, however, would never be considered a close one. How is it with the wells of houses whose walls touch each other? How with those of houses situated below numbers of others on a slope?

However free a well may be from danger of drainage-pollution, it should be examined yearly in the dry season, and cleared of all droppings and settlings. Wood from curbing or pump, dirt from the sides, burrowing animals, earthworms, slugs, etc., etc., are often found rotting in the bottoms of wells. Of course the cleaning is not thorough unless a man descends, examines and remedies all defects.

Cisterns are liable to the same dangers with wells, and usually have carried into them much more fine dirt in suspension, washed away from the roofs which form their "watershed." Even when made with an effective filter-chamber, they should be examined and cleaned every summer—oftener, if their water grows distasteful. Who is not familiar with the strong smell of water from cisterns, which has been furnished him for bathing? Cisterns are also liable to be cracked or burst by pressure from within or without, in consequence of the soil around them not affording support enough; or by pressure from beneath, as the subsoil water rises. Being thus rendered leaky under pressure from without, they are occasionally entered by polluted water at times when their contents cannot leak against the external pressure. From

just such a cause there occurred in the autumn of 1874 an epidemic of typhoid fever in a boarding school in Burlington, New Jersey, a full report of which may be found in the "Philadelphia Medical Times" for May 29, 1875. It is interesting to note that the infecting agent in this case was the leakage into the subsoil from a privy-vault which had been strongly and carefully built only three years before.

The "overflow" of cisterns furnishes another channel of possible contagion, which should be borne in mind, as capable of admitting gases as well as fluids. It being probable that cisterns will be more and more used as substitutes for wells, where soil-contamination is on the increase, and before an aqueduct supply is secured, it is important that they should be built and maintained with intelligent care, and that their owners should not rest secure in the idea that because they no longer use well-water they are in no danger of drinking fouled water. Whatever be the source of supply, "eternal vigilance is the price," the only price, of safety.

The aqueduct, the third source of supply, is the method which all large towns must of necessity resort to, and which, apart from the question of cost, commends itself to all communities by its convenience, its abundance, and its comparative purity. In our Commonwealth it has already been adopted with more or less completeness by forty-six cities and towns, comprising 963,721 persons, or a little over one-half of the entire population.

Water-Supply and Sewerage.

In the following five tables are gathered certain statistics in regard to the towns thus supplied. It is probable that it is not complete as regards all the smaller towns of the State, which, having partial aqueduct supplies, have not replied to the circular of the Board. Another year will undoubtedly remedy this incompleteness, and meanwhile it is certain that we have some facts in regard to all the larger towns. It would be interesting to know how many towns are now discussing the question of a public water-supply, since it is evident that there is a general awakening to the importance as well as the convenience of it.

These tables furnish, with as much completeness as has

 [See p. 200.

Twelve Cities supplied by Aqueduct, having a population of 20,000 and more.

City or Town.	Effect on health.	Dwellings.	Dwellings taking water.	Population.	Water. Source of Supply and Date of Introduction.	Water. Daily capacity in gallons.	Sewers. Total length, in miles.	Sewers. Where discharged.
Boston,[1] . .	Some improvement,	-	-	341,919		64,000,000	166	The outlets encircle the city proper.
Cambridge,[2] .	Probable benefit, but no proof.	7,760	-	47,838	Fresh Pond, 1857; Spy and Little ponds, 1876.	6,000,000	40	Charles River, Alewife Br'k.
(Charlestown,[3])	Not proved to be affected.	-	-	‡	Mystic Pond, . . .	-	-	Charles, Mystic and Miller's rivers.
Chelsea,[4] . .	Thought to be favorable.	3,651	-	20,695	Mystic Pond, . . .	Mystic supply, 12,000,000	17	Chelsea Creek, Mystic River.
Fall River,[5] .	Improved, where used.	4,610	-	45,340	Watuppa Lake, . . .	-	-	Mt. Hope Bay, partly by way of "Fall River."
Lawrence,[6] .	Too recent, . .	4,370	-	34,907	Merrimac River, . .	-	-	Merrimac, Spicket and Shawshine Rivers.
Lowell, . .	Good; typhoid believed to be lessened.	7,800	-	49,677	Merrimac River, through filter-chamber, 1872-3.	2,500,000	12.4	Concord River, Merrimac River.
Lynn,[67] . .	Statistics show decrease of typhoid.	5,067	3,586	33,000	Two ponds, made by damming brooks on the edge of city, 1870.	1,500,000	7	Lynn Harbor.
[illegible]		[illegible]	15,000 persons	26,876	Acushnet River, dammed,	Enough for four-fifths of population.	14	New Bedford Harbor, twelve outfalls into deep water.

Salem,* . .	Partial supply for years. No change since full supply.	3,388	-	25,966	Wenham Lake, . . .	-	-	Harbor, North River, Mill Pond.
Somerville,[10] .	Very good; less typhoid and kindred diseases.	3,968	-	21,868	Mystic Pond, . . .	-	14	Charles River, Mystic River.
Springfield,[11] .	Too recent, . .	4,977	-	31,053	Reservoir in Ludlow, .	-	-	Connecticut River.
Worcester,[12] .	Good; less typhoid,	6,086	-	49,265	Reservoir, fed by Lynde Brook.	-	-	Blackstone River, by Mill Brook.
				726,903				

Nine Cities and Towns supplied by Aqueduct. Population from 10,000 to 20,000.

Adams,‡[13]. .	Can hardly be ascertained, but advantageous.	2,002	Eight hundred families.	15,760	Mountain stream, 1865, .	Varies from 2½ to 6 millions.	-	No sewers.
Brockton,[14] .	Unpalatable; not used for drinking or cooking.	1,769	One-fourth of all, perhaps less.	10,578	Pumped from large brook to small reservoir in centre, 1870.	Small, . . .	-	No sewers.
Chicopee,[15] .	Diarrhœa when the season of low and impure supply occurs.	1,214	Nearly all, .	10,331	Private Co. Springs in high plateau, 1830.	Scanty and intermittent.	-	No sewers.

* Average daily use 1,339,290 gallons. † Used lavishly. ‡ Included in Boston.

[1] Sewerage very unsatisfactory.
[2] Sewerage very unsatisfactory.
[3] Sewerage very unsatisfactory.
[4] Sewerage calls for improvement.
[5] "Fall River" portion, sewerage unsatisfactory.
[6] Merrimac portion, sewerage satisfactory; Spicket portion unsatisfactory.
[7] Sewerage bad.
[8] Sewerage very satisfactory.
[9] Harbor portion, sewerage unsatisfactory; North River portion vile; easily remedied.
[10] Sewerage very unsatisfactory.
[11] Good plan of sewerage begun upon.
[12] Fouls the river visibly for seven miles; discussing a system of irrigation, and rapidly improving sewerage within city.
[13] Has rapid surface-drainage into Hoosac River.
[14] Two-thirds sewage runs on surface.
[15] Drains finally into Connecticut River.

City or Town.	Effect on health.	Dwellings.	Dwellings taking water.	Population.	Water. Source of Supply and Date of Introduction.	Water. Daily capacity, in gallons.	Sewers. Total length, in miles.	Sewers. Where discharged.
Fitchburg,[1] .	Too recent; still, thought to be less sickness.	1,974	-	12,289	Reservoir fed by small stream, 1871-72.	One million, can be trebled.	-	Nashua River.
Haverhill,[2] .	Salutary, . . .	2,643	10,000 persons.	14,628	Three ponds, 1801; and Merrimac River, 1849. Private Co.	Capable of indefinite increase.	-	Merrimac River, Little River.
Holyoke,[3] .	None observable, .	1,479	-	16,260	Deep, natural ponds, 1872, abundant and pure.	3,000,000	-	Connecticut River.
Malden, . .	Decidedly good, .	1,923	-	10,843	Spot Pond, 1870, . .	-	-	Cesspools.
Northampton,[4].	Too recent, . .	1,823	-	11,108	Mountain stream, 1871, .	-	-	No system.
Pittsfield, . .	Generally thought to be improved.	2,052	-	12,267	Ashley Lake, 1855; Sacket Brook, 1875.	-	2	West Branch of Housatonic River.
				114,064				

Ten Towns supplied by Aqueduct. Population from 5,000 to 10,000.

City or Town.	Effect on health.	Dwellings.	Dwellings taking water.	Population.	Water. Source of Supply and Date of Introduction.	Water. Daily capacity, in gallons.	Sewers. Total length, in miles.	Sewers. Where discharged.
Attleborough,[5] .	No appreciable effect as yet.	1,520	-	9,224	Ten Mile Brook and large well, 1874.	Maximum, 800,280	-	None.
Beverly,[6] . .	Good; much less fever, especially typhoid.	1,300	-	7,263	Wenham Lake, . . .	-	-	None.
(Brighton,[7]) .	Too recent, . .	907	-	‖	Lake Cochituate, 1875-6, .	-	-	Natural outlet, Charles River.

Brookline,†[6] .	Too recent, . .	1,096	870	6,675	Charles River, by filtering-chamber, 1875–6.	1,800,000	8	Charles River, through Muddy Brook, with tide-gate.
Medford,[9] .	Considered good, .	1,374	1,100 takers.	6,627	Spot Pond, 1870, . .	-	-	No system. Drains into Mystic River.
Natick,[10] .	No perceptible effect as yet.	1,195	-	4,419	Dug Pond, ...	-	-	No system.
Peabody,[11] .	Partial supply; no typhoid among water takers.	1,350	-	8,066	- -	-	-	Tanneries, etc., and some dwellings, into Procter's Brook and Goldthwaite's Brook, thence into North River in Salem.
Plymouth,[12] .	Typhoid the rarest disease.	1,288	-	6,370	Large natural pond, 1856,	-	A few sewers, .	Plymouth Harbor, bare at low tide.
Waltham,‡[13] .	Too recent, . .	1,317	-	9,945	Charles River, by filtering-chamber, 1874.	1,250,000	-	No system. Natural outlet into Charles River.
Westfield,[14] .	Too recent, . .	1,468	-	8,429	Two reservoirs, by damming brook five miles distant.	-	-	No sewers.
Woburn,§[15] .	More sickness in two years since water than in preceding two.	1,626	-	9,568	Wells at Horn Pond, 1873,	1,200,000	-	Natural outlet into head waters of Mystic Pond, where most of the tanneries now discharge, also some dwellings.
				76,586				

* Average daily use, 75,000 gallons. † Average daily use, in summer, 330,000 gallons. ‡ Average daily use, 600,000 gallons.
§ Average daily use, 170,000 gallons. ‖ Included in Boston.

1 Beginning to execute a plan for sewerage. River already fouled to sight, but not to smell. 2 Little River Valley in a bad condition. See Haverhill in Report.
3 Has a plan of sewerage, and is executing it. 4 Into brooks and Mill Brook. 5 Much needed. Sewerage under discussion.
6 Much needed. 7 Sewerage system begun upon, together with introduction of water.
8 A good system begun upon systematically. Outlet objectionable to Boston. 9 Cesspools generally in use.
10 Most of the sewage runs into Pegan Brook, thence into Lake Cochituate. 11 See Report on Peabody and Salem. Open stream through centre, the main sewer.
12 Existing sewers have no traps, and their gases are blown back by east wind at outlets. 13 Cesspools mainly used.
14 Three-fourths sewage into cesspools, one-fourth into streams and ponds. 15 Discussing a plan of sewers. See Report on Woburn, Winchester, Mystic Pond.

Nine Towns supplied by Aqueduct. Population 3,000 to 5,000.

Towns.	Effect on health.	Dwellings.	Dwellings taking water.	Population.	Water.		Sewers.	
					Source of Supply and Date of Introduction.	Daily capacity, in gallons.	Total length, in miles.	Where discharged.
Arlington,[1] .	None perceptible, .	615	-	3,906	Reservoir on East Lexington meadows. Brook dammed; mainly rainfall, 1874.	-	None, . .	- -
Easthampton,[2] .	None noted, . .	586	-	3,964	Reservoir for fire department.	-	Imperfect system.	Into brook below pond.
Everett, . .	Salutary, . . .	770	-	3,651	Mystic Pond, . . .	-	None for dwellings.	Upon marsh.
Gt. Barrington,[3]	Very decidedly good,	839	Every one, .	4,385	Mountain stream, 1871, .	-	None, . .	One-third into Housatonic River.
Hopkinton, .	No definite report, .	768	-	4,508	Private supply for 100 families and two factories, from spring in centre.	-	None, . .	Sewage mainly on surface.
Leominster,[4] .	Too recent, . .	924	-	5,200	Reservoir at foot of Monoostock Mt., 1873.	-	Two street sewers.	Planned to discharge into brook below mills, thence into Nashua River.
South Hadley, .	Recent. No perceptible effect.	502	-	3,370	From brook for South Hadley Falls.	-	None, . .	- -
Winchester,[5] .	Too recent. Health always very good.	554	356*	3,099	Rainfall. Reservoir in elevated valley dammed, 1874.	Actual, 800,000; possible, 1,600,000.	None, . .	Natural drainage into Abajonna River, thence into Mystic Pond.
W. Springfield,[6]	Not fairly in use yet,	680	12†	3,739	Reservoir on brook, 1875–76.	-	Beginning, .	- -
				35,817				

Six Towns supplied by Aqueduct. Population less than 3,000.

Ashfield, . .	- -	257	Nearly all, .	1,190	Springs. Private pipe to each house. Many yrs.	-	None, . .	Surface and cesspools.
Concord,[7] . .	Too recent, . .	470	126	2,676	Flint's Pond, in Lincoln, 1874.	500,000	None, . .	Surface and cesspools.
Kingston, . .	- -	354	40	1,569	Forced from springs by Private Co.	-	None, . .	Surface and cesspools.
Lincoln, . .	Not used, . . .	147	Very few, .	834	Flint's Pond, 1875, . .	-	None, . .	Surface and cesspools.
Stockbridge, .	Typhoid once common; now very rare.	451	17	2,089	Private Co. From springs in East Mountain.	-	None, . .	Three-fourths on surface.
W. Brookfield, .	- -	345	Nearly all, .	1,903	Three private companies, 1865. Reservoirs dug in hills, 1870. Two by lead pipe; one by block tin.	-	None, . .	Surface and cesspools.
				10,261				

* Also fifty-five stables, factories, etc. † Also the public buildings.

1 Sewage mainly into cesspools. Gas factory into Mill Brook, thence into Mystic Pond.
2 Sewerage under consideration.
3 One-third on surface, one-third into cesspools.
4 Sewerage under discussion.
5 See Woburn, Winchester, Mystic Pond.
6 Considering sewerage and introducing water.
7 Sewerage much needed.

Cities supplied by Aqueduct. Population.

Class I.,	726,963	963,721
II.,	114,064	
III.,	76,586	
IV.,	35,817	
V.,	10,261	

been practicable, certain statistics with regard to each of these towns; viz., the effect of its aqueduct-supply on the general health of its population, the whole number of dwellings, the number of dwellings (sometimes of families) using the water, the population of the town, the source of water-supply and date of introduction, the daily capacity (in United States gallons) of this supply, and, as most closely connected with the free use of water, a few important facts concerning the sewerage of the town; viz., the length (in miles) of it sewers, the place of their final discharge or outfall, and finall brief memoranda indicating the present state of the sewerag question in the town.

For the purpose of facilitating comparison between the owns, they have been arranged in five groups, according opulation, giving of those with a population of 20,000 a pwards, 12; from 10,000 to 20,000, 9; from 5,000 to 10,0 0; from 3,000 to 5,000, 9; less than 3,000, 6.

In proportion as the advantages of aqueducts are appr ted, the importance of preserving our streams and po rom pollution will be more strongly felt, inasmuch as, single exception, to be hereafter mentioned, they afford nly sources for aqueduct-supply. It is to be hoped tha eople will be aroused to a jealous care for their preserv efore it is too late.

Twenty cities and towns now depend on streams, 1 reat ponds, 7 on springs, 2 towns on "gathering-grou nd 1 town on ponds and springs.

It is of course understood that all these sources r hemselves at last into the rainfall, being so many di orms of its reappearance on (or very near) the surface round. Rivers are the open drains; ponds the eservoirs; springs smaller forms of the same, fed by a ure water-shed, sometimes hard by, sometimes farthe nd carried awhile by an underground channel, to r s "a spring," or perhaps to be tapped by a well. ill, lake or spring, on the surface or subterranean, ll modifications of this same rainfall, subject to filt pollution from the strata over or through which it ay to its natural drains or reservoirs. No person ary intelligence now hopes to secure a water-sup

the bowels of the earth, which has never been subjected to possible pollution from organic matter.

All our water for domestic and manufacturing purposes must be rainfall, which we are to get as pure as possible; and if we are not speedily and energetically on our guard, we shall be too late to get it wholesomely pure from sewage, the moist refuse of civilized life. By "gathering-grounds" is here meant such reservoirs of primary rainfall as may be made by damming some small valley suitably situated in relation to the community needing the water-supply; a valley into which no stream enters, and where no large pond has a natural existence. The streams of our State are well known. The great ponds are well treated of in the Report of the State Board of Health for 1873, where may be found a list of them, with the size of each. It may be well here to repeat that these ponds comprise one fifty-fourth of the whole territory of Massachusetts, and are public property; also that they are, for the most part, bordered by farms and woodlands, rarely by villages. It is probable that some towns, perhaps many, might make a great pond, in a place suitable for a "gathering-ground," and thus obtain a water-supply with as signal success as has been attained in Winchester.*

As a matter of course a town in deciding upon water-supply becomes alive to the importance of securing perpetual purity for such water, and can understand the immense importance of controlling the water-shed which may supply it, so as to guard against sewage-contamination at the source. And, as the sewerage problem is certain to follow close at the heels of the water question, it is a pertinent inquiry, and one deserving closer attention than it seems to have hitherto received, whether a danger may not arise from the contiguity of sewers and water-mains of thin iron lined with cement.

From the dangers attendant on an intermittent aqueduct supply we are fortunately almost wholly free, every supply reported, with the exception of that of Chicopee, being constant. The dangers of the intermittent system are: 1. The liability when a vacuum occurs in the pipes that sewage or sewage-gas may be sucked into the pipes (main, supply or service). 2. The deterioration of the supply, which under

* See "Winchester," in this Report.

stem must be drawn in advance daily in every dwelling ome receptacle, on account of heating and incipient position.

n the first-named evil several places in England have d severely in the form of epidemics of typhoid fever; veral of these have been investigated in the most thor- manner, and the method, place and time of specific iination have been demonstrated. From the second every one who has this kind of supply must suffer, as en the experience in Chicopee for some years.* Ice tigate, but not remedy it.

further convenience of reference, the towns with aque- apply which report any existing system of sewers are ed as draining into "salt-water bays, etc.," into "tidal s," or into "fresh-water streams."

TS OF SEWER SYSTEMS OF TOWNS REPORTING ANY SYSTEM.

I.—*Into Salt-water Bays, etc.*

. .	Boston Harbor, also into Charles River and other tidal waters.
er, . .	Mount Hope Bay, partly into Fall River.
. .	Lynn Harbor.
dford, .	New Bedford Harbor.
th, . .	Plymouth Harbor; outlet bare at low tide.
. .	Salem Harbor, North River, Mill Pond.

II.—*Into Tidal Streams.*

ne, . .	Charles River, through Muddy Brook, with tide-gate.
ige, . .	Charles River (also into Alewife Brook, fresh).
town, .	Charles, Mystic and Miller's rivers.
, . .	Mystic River, Chelsea Creek.
. .	Ditches on salt marsh, thence into Mystic River.
ille, . .	Charles River, Mystic River.

III.—*Into Fresh Streams.*

npton, .	Brook, below pond.
rg, . .	Nashua River.
arrington,	Housatonic River (about one-half).
ll, . .	Merrimac and Little rivers.
, . .	Connecticut River.
ce, . .	Merrimac, Spicket and Shawshine rivers.
ster, . .	Brook, which empties into Nashua River.

* See "Chicopee," in this Report.

Lowell, . .	Merrimac and Concord rivers.
Peabody, . .	Procter's and Goldthwaite's brooks.
Pittsfield, . .	Housatonic River, West Branch.
Springfield, . .	Connecticut River.
Worcester, . .	Blackstone River, by Mill Brook.

Of the towns reporting no systems of sewerage, 123 discharge one-half or more of their sewage upon or into the surface; 89 discharge two-thirds or more in this way; nine discharge the whole. There are also 14 large towns or cities where much runs upon the surface, though less than one-fourth of the total sewage of the place. Lists of these classes are subjoined. And following them are lists of towns which report that "such sewage is often or strongly offensive," with a statement in each case as to the observed effect of such emanations on health.

Nine Towns where the Whole Sewage runs on or into the Surface.

Ashfield.	Ipswich.	North Adams.
Danvers.	Mansfield.	Plainfield.
Greenwich.	New Braintree.	Sutton.

Eighty-nine Towns where more than One-half goes on the Surface.

TOWN.	Sewage running on or into surface.	TOWN.	Sewage running on or into surface.
Amesbury,	. Four-fifths.	Chester, .	. Nearly all.
Andover, .	. Nearly all.	Colrain, .	. Nearly all.
Ashby, .	. Four-fifths.	Canton, .	. Five-eighths.
Abington, .	. Four-fifths.	Concord, .	. 73 per cent.
Amherst, .	. Three-quarters.	Dover, .	. Five-eighths.
Barnstable,	. Nearly all.	Dudley, .	. Nearly all.
Belchertown,	. Five-eighths.	Dennis, .	. Two-thirds.
Berkley, .	. Nearly all.	Easthampton,	. Nearly all.
Berlin, .	. Three-quarters.	Eastham, .	. Nearly all.
Blandford,	. Nine-tenths.	E. Bridgewater,	Nearly all.
Beverly, .	. Very large proportion.	Falmouth,	. Three-quarters.
		Fairhaven,	. Large proportion.
Bridgewater,	. Seven-eighths.	Foxborough,	. Nearly all.
Brimfield,	. Very large proportion.	Fall River,	. Large proportion.
		Fitchburg,	. Four-fifths.
Barre, .	. Nearly all.	Gt. Barrington,	Two-thirds.
Blackstone,	. Six-tenths.	Groveland,	. The most of it.
Braintree, .	. Seven-tenths.	Grafton, .	. Greater part into cesspools.
Brewster, .	. Five-eighths.		

TOWN.	Sewage running on or into surface.	TOWN.	Sewage running on or into surface.
Harwich, .	. Two-thirds.	Raynham,	. More than three-quarters.
Heath, .	. Nearly the whole.	Revere, .	. Seven-eighths
Holden, .	. More than half.	Rowe, .	. Nearly all.
Hardwick,	. Nearly all.	Shelburne,	. Half in the village, seven-eighths among the farmers.
Hopkinton,	. Nearly all.	Shirley, .	. Nearly all.
Hadley, .	. Nine-tenths.	Shrewsbury,	. Nearly all into sink-holes.
Hudson, .	. Nineteen-twenty-fourths.	South Scituate,	. One-third on to sur face, one-thir into sink-hole which are th most offensive.
Kingston, .	. Nearly all.	Stoughton,	. Three-quarters.
Lunenburg,	. Nearly all.	Swampscott,	. One-half on to s face, one-te into cesspools
Ludlow, .	. Five-sixths.	Tewksbury,	. Nearly all.
Littleton, .	. Three-quarters.	Tisbury, .	. Three-quarters.
Leominster,	. Large part.	Topsfield, .	. Nearly all.
Lexington,	. One-half on to surface, three-eighths into cesspools.	Upton, .	. Five-eighths.
Middlefield, .	Nine-tenths.	Walpole, .	. Four-fifths.
Montague,	. A large part.	Westfield, .	. Three-quarter
Montgomery,	. The largest part.	Westhampton,	. Nearly all.
Marblehead,	. Three-fifths.	W. Brookfield,	. Nearly all.
Mt. Washington,	Three-quarters.	W. Newbury,	. Nearly all.
Monterey, .	. Three-quarters.	W. Stockbridge,	Three-quarte
Milford, .	. Four-fifths.	Wilbraham,	. A small part surface, a part into pools.
Middleborough,	The larger part.	Winthrop,	. Nearly all.
Medford, .	. 85 per cent.	Weymouth,	. Seven-tenth
Nahant, .	. Nearly all into cesspools.	Yarmouthport,	. Nearly all.
No. Reading,	. A large part among the farmers.		
Northborough,	. Three-quarters.		
Needham,	. Two-thirds into cesspools.		
Orange, .	. Four-fifths.		
Oxford, .	. Three-quarters.		
Pembroke,	. Seven-eighths.		
Pepperell,	. Nearly all.		
Randolph,	. Two-thirds into cesspools.		

Twenty-five Towns where between One-quarter and O goes on Surface.

TOWN.	Sewage running on or into surface.	TOWN.	Sewage run into su
Ashburnham,	. One-half.	Huntington,	. One-half.
Brockton, .	. One-half.	Hatfield, .	. One-half.
Clinton, .	. One-half.	Lancaster,	. One-half.
Enfield, .	. About one-half.	Malden, .	. One-half

TOWN.	Sewage running on or into surface.	TOWN.	Sewage running on or into surface.
Medway, .	. One-half.	Sheffield, .	. One-half.
Nantucket,	. One-half.	Stoneham,	. One-half.
New Salem,	. One-half.	Somerset, .	. One-half.
Orleans, .	. One-half.	Wakefield,	. One-half.
Otis, . .	. One-half.	Westborough,	. One-half. [pools.
Quincy, .	. One-half.	Ware, .	. One-half into cess-
Rockport, .	. One-half.	Webster, .	. One-half.
South Hadley,	. One-half.	Winchester,	. Nearly one-half.

Fourteen Large Towns or Cities where Much goes on Surface, though less than One-quarter.

Chicopee.	Lawrence.	Watertown.
Gloucester.	Peabody.	Woburn.
Haverhill.	Springfield.	West Roxbury.
Lowell.	Taunton.	Somerville.
Lynn.	Worcester.	

QUESTION IV.—"*Is such Sewage often or strongly offensive?*"

Eighty-seven of the one hundred and eighty-eight towns answer in the affirmative. Twenty-four report resulting disease. Sixty-five report no disease in this connection. Eight report that such stench* is suspected of causing disease. The diseases reported as resulting are typhoid fever, cerebro-spinal meningitis, diphtheria, typhoid pneumonia, dysentery, diarrhœal diseases in children, scarlatina. Several observers report "injury to health," and "increased prevalence of disease," even where no special diseases are traced to it.

It is a matter of prolonged and common experience among physicians that the poison of several diseases is received more virulently and more speedily through the lungs than through the stomach. Of others we do not positively know that they ever enter the system through the stomach, but we have evidence that they frequently do so through the lungs. And this is precisely what one would expect from the unceasing flow into the lungs of whatever the atmosphere carries, and of its comparatively direct access to the blood within the pulmonary vessels.

It is easy to understand the high death-rate of Boston, when

* This word, as used here and subsequently, includes all emanations associated with the stench.

one observes, on the map of the "Metropolitan District," with this paper, how the city is surrounded with sewer-outlets. It is also easy to understand how any family in the country may create for itself, by means of surface-sewage, as foul an air as is inflicted on the unfortunates who dwell close by the outlet of a great city sewer. Many of the "correspondents" from country towns report the habitual use of dry earth as an absorbent and disinfectant of surface-sewage with the effect of at once saving health and manure, and they bear testimony to the increase of interest and knowledge in regard to sanitary laws among their townsfolk. On the other hand, many correspondents report gross ignorance and indifference touching all sanitary matters.

The following lists speak for themselves to a considerable degree, but in studying them, as well as the tables illustrating the subject of polluted drinking-water under the next heads (V. and VI.), it must be borne in mind that the conclusion to be drawn is not that, of the one hundred and seventy-seven returns of wells fouled and frequent stench from surface-sewage, eighty-seven only were associated with disease, but that it was possible to trace distinctly the association of sewage and disease, as cause and effect, in that proportion.

We do not attempt to work out the statistics further, because the necessary data are lacking, and it was not proposed in this paper to collect them; but to avoid misapprehension, we will say that of the above eighty-seven, almost every one represents several instances of disease, many represent tens, some represent scores of instances. Moreover, the medical correspondents do for the most part believe that such connection between filth and disease exists in their practice very much more frequently than they are able to demonstrate. There has been a very marked growth of the scientific spirit of accuracy among physicians, which renders them more and more on their guard about speaking positively in relation to the causation of stated cases of disease which have not been specially investigated. But never was there a time when physicians were so assured that many classes of disease can be prevented by right living, and foremost among the preventable diseases they class those connected with filth.

In this connection the reader is referred to papers in previ-

ous reports of the Board,* and to the lists in the present paper of towns which discharge the greater part of their sewage on the surface; also to the tables of towns with aqueduct-supply in the column headed "Effect on Health," as showing the decrease of typhoid fever where pure water is introduced.

Twenty-one towns report disease from emanations of surface-sewage; nine report typhoid as being so caused; two report diphtheria; one reports meningitis; one reports cholera; one reports pneumonia; one reports dysentery; one reports cholera infantum; one reports scarlatina.

List of Twenty-one Towns reporting Stench from Surface-Sewage, and Resulting Disease.

Chicopee, .	Very offensive stench from factory privies. Typhoid and meningitis.
Charlestown, .	Stench from the various varieties of sewage discharged on flats, bare at low tide, sometimes creates nausea and affects health unfavorably, if not causing special disease.
Haverhill, .	Valley of Little River.
Holyoke, .	Terrible epidemic of typhoid in 1874, when a large and long-used public cesspool was drained off. See Report State Board of Health, 1875 (Health of Towns).
Lowell, . .	See Report Board of Health, 1874 (Health of Towns).
Lynn, . .	"Many and notable instances."
Lexington, .	Typhoid fever, diphtheria, one case of cholera.
Lawrence, .	Typhoid pneumonia.
Malden, . .	Occasionally strong stench, considered dangerous.
Monson, . .	Occasionally.
Montague, .	Seven cases typhoid fever, with two deaths in one family from sewage-stench in the cellar.
Plymouth, .	Two cases typhoid fever from sewage in cellar.
Peabody, .	Typhoid fever sometimes traced to stench from sewage on surface.
Pittsfield, .	In some localities.
Quincy, . .	In some cases, typhoid.
Salem, . .	Intolerable stench and resulting disease.
Springfield, .	Some sewers discharge on river bank with detriment to health.
So. Dennis, .	
Wakefield, .	One very bad locality.
Webster, .	Frequent typhoid and dysentery.

* Causes of Typhoid Fever in Massachusetts, 1871. Mill-Dams and Water Obstructions, 1872. Drainage for Health, 1873. Sewage and Sewerage, 1873. Considerations touching Water-Supply, etc., 1874. Value of Health to the State, 1875.

›burn,	. Along line of Russell's Brook (see Report of State Board of Health, 1875).
›rcester,	. Cholera infantum, diphtheria, scarlatina.

ʹst of Sixty-five Towns reporting Sewage-Stench WITHOUT *Resulting Disease.*

lchertown.	Huntington.	Plainfield.
verly.	Hardwick.	Raynham.
ɪdgewater.	Harwich.	Rockport.
imfield.	Hatfield.	Reading.
rkley.	Hyde Park.	Randolph.
ɪrre.	Hudson.	Stoughton.
ɪckstone.	Lunenburg.	Shirley.
aintree.	Ludlow.	Shelburne.
nton.	Monterey.	South Scituate.
nton.	Milford.	Sheffield.
mbridge.	Middleborough.	Stoneham.
elsea.	Medford.	Somerset.
dley.	Medway.	Sutton.
nvers.	Nahant.	Taunton.
stham.	Natick.	Upton.
ston.	North Andover.	Uxbridge.
lmouth.	North Reading.	Warren.
ll River.	New Salem.	Weymouth.
chburg.	Newton.	Winchester.
rdner.	Northampton.	West Stockbridge.
bertville.	Orange.	West Newbury.
eenwich.*	Pembroke.	

st of Eight Towns reporting Sewage-Stench, and SUSPECTING *it of Causing Disease.*

dover.	Charlestown.	Montgomery.
ɪol.	Cambridge.	Swampscott.
ington.	Fitchburg.	

"QUESTION V.—*Are Wells or other sources of Water-ɪpply exposed to contamination from Sewage?*"

Of the 188 cities and towns reporting, 90 reply to this estion in the affirmative; and of these, 3 send no report resulting disease; 16 report no resulting disease; 8 are certain of resulting disease; 63 report distinct resulting ease.

Of the 63 reporting disease, 44 report typhoid fever; 6

* Strongly offensive.

report dysentery; 4 report scarlet fever; 2 report diphtheria; 2 report cerebro-spinal meningitis; 11 report simply "disease."

From some of the towns several diseases are reported as probably so caused in each.

List of Towns where the Water for Drinking is more or less Polluted, with Results in Disease, so far as known.

Name of Town.	Disease.	Amount and Character.	Single or Repeated Cases.	Source of Supply.
Abington, . .	Disease, . .	Occasional, .	-	Few wells.
Athol, . .	None, . .	-	-	Wells.
Ashfield, . .	Meningitis, .	Serious, . .	One, . .	One well.
Arlington, . .	Disease, . .	-	-	Few wells.
Amherst, . .	None of late, .	-	-	Wells often.
Barnstable, .	Typhoid, . .	Occasional, .	-	Wells.
Brighton, . .	" . .	-	Repeated, .	Many wells.
Berlin, . .	Disease, . .	Serious, . .	One, . .	Wells.
Beverly, . .	Typhoid, . .	Frequent, .	-	"
Brimfield, . .	" . .	Serious, . .	One, . .	"
Brockton, . .	" . .	-	Repeated, .	Wells very bad.
Blackstone, .	" . .	-	-	Wells.
Braintree, . .	" . .	Frequent, .	Repeated, .	"
Chicopee, . .	Diarrhœa, . .	" .	-	Aqueduct and many wells.
Clinton, . .	Typhoid, . .	-	Repeated, .	Wells.
Canton, . .	No report, . .	-	-	"
Concord, . .	Disease, . .	-	-	Some wells.
Dudley, . .	Typhoid and dysentery.	Frequent, .	Repeated, .	Many wells.
Dennis, . .	Suspected, . .	-	-	Wells possibly.
Danvers, . .	None, . .	-	-	Wells exposed.
Easton, . .	Disease, . .	Very seldom, .	-	Some wells.
Fairhaven, . .	" . .	Fatal, . .	-	Wells probably.
Foxborough, .	Probably none, .	-	-	Wells.
Fall River, .	Typhoid, . .	-	-	"
Fitchburg, . .	Enteric and scarlet fevers.	-	Repeated, .	-
Granby, . .	None. . .	-	-	Wells.
Greenwich, .	Typhoid, . .	-	-	"
Huntington, .	" . .	-	-	Wells probably.
Harwich, . .	" suspected,	-	Repeated, .	Some wells analyzed and thought safe.
Hardwick, . .	" . .	-	Large number.	Wells.
Hadley, . .	" . .	Serious, . .	Five in one house.	Some wells.
Hudson, . .	" . .	-	Six in one house.	-
Lunenburg, .	None, . .	-	-	Few wells.

List of Towns, etc.—Continued.

Name of Town.	Disease.	Amount and Character.	Single or Repeated Cases.	Source of Supply.
Lowell, . .	Typhoid, . .	Frequent and severe.	Repeated, .	Cisterns and wells.
Ludlow, . .	" . .	Bad, . .	"	Wells often.
Leominster, .	" . .	Serious, . .	Twenty from one well.	One well.
Lynn, . .	" . .	Serious and abundant.	-	Wells.
Leverett, . .	" . .	Serious, . .	Whole family,	"
Lexington, . .	Disease, .	-	-	Few wells.
Lawrence, . .	Typhoid and dysentery.	Sporadic, . .	Repeated, .	Wells.
Malden, . .	Typhoid, . .	-	Several, .	-
Marblehead, .	None, . .	-	-	Few wells.
Mt. Washington,	Enteric fever, .	-	-	Wells.
Monterey, . .	Typhoid, . .	Occasional, .	-	Some wells.
Mansfield, . .	None, . .	-	-	Wells.
Milford. . .	Typhoid, . .	Persistent and fatal.	Four from one well.	Water analyzed—not fit to use.
Middleborough,	None, . .	-	-	Some wells abandoned.
Medford, . .	Typhoid and meningitis.	Serious, . .	One, . .	Few wells.
Medway, . .	Diphtheria, .	Fatal, . .	Repeated, .	Wells.
Natick, . .	Doubtful, . .	-	-	"
Nahant, . .	Typhoid, . .	Serious, . .	One, . .	"
North Andover,	None, . .	-	-	"
North Reading,	Typhoid, . .	-	-	Few wells; very bad.
New Salem, .	None, . .	-	-	Wells.
Newton, . .	No report, . .	-	-	"
Needham, . .	None, . .	-	-	Wells sometimes.
Orange, . .	" . .	-	-	Wells.
Plainfield, . .	" . .	-	-	"
Pittsfield, . .	Typhoid, . .	Serious, . .	Repeated, .	"
Quincy, . .	" . .	-	-	"
Raynham, . .	Diarrhœa, . .	-	-	"
Rockport, . .	Doubtful, . .	-	-	Water.
Reading, . .	Probable, . .	-	-	Wells.
Randolph, . .	Disease, . .	-	-	Water.
Stoughton, . .	Doubtful, . .	-	-	Wells often.
Shirley, . .	Typhoid, . .	-	Repeated, .	Water.
Stockbridge, .	None, . .	-	-	Few wells.
Shelburne, . .	" . .	-	-	Wells.
South Scituate, .	Typhoid, . .	Serious, . .	One, . .	"
Shrewsbury, .	Low fever, . .	-	-	Some wells.
Sheffield, . .	Typhoid, . .	Occasional, .	Repeated, .	"
Springfield, .	Uncertain, . .	-	-	Water.
Taunton, . .	Diarrhœa and enteric fever.	-	Repeated, .	Wells.
Upton, . .	Dysentery and gastritis.	Serious, . .	Epidemic—9 in one family.	Few wells.
Wakefield, .	Typhoid, etc., .	" . .	-	Wells.
Waltham, . .	" . .	-	-	Many wells.
Walpole, . .	" . .	Serious, . .	One, . .	Wells.
Wilmington, .	No report, . .	-	-	"
Worcester, . .	Typhoid, . .	-	-	Some wells.

List of Towns, etc.—Concluded.

Name of Town.	Disease.	Amount and Character.	Single or Repeated Cases.	Source of Supply.
Warren, . .	Typhoid probably.	-	-	Water.
Webster, . .	Doubtful, . .	-	-	Wells often.
Wrentham, .	Uncertain, . .	-	-	Some wells.
Weymouth, .	Disease, . .	Rare, . .	-	Few wells.
Watertown, .	" . .	Very little, .	-	Wells probably.
Westborough, .	Diphtheria and scarlet fever.	Serious, . .	Family of 7, 4 died.	Few wells.
Winchester, .	Typhoid, none of late.	Very rare, .	Two in one family.	Wells rarely.
Woburn, . .	Typhoid, . .	-	Repeated, .	Water.
West Newbury,	" etc., .	-	Two, . .	Wells probably.
West Roxbury, .	" .	-	-	Many wells.

Of these 90 towns reporting *polluted drinking-water*, 3 send no report of disease; 16 report "no disease"; 8 report "doubtful"; 63 report disease.

Of these 63 reporting disease, 44 report typhoid; 2 report meningitis; 2 report diphtheria; 6 report dysentery, etc.; 5 report scarlet and other fevers; 11 report "disease," without specifying the kind.

"Question VII.—*If any water-courses or ponds are used to receive sewage from manufactories or other sources in your town (or city), will you please give some account of them?*

"*(a.) As to pollution of drinking-water.*

"*(b.) As to pollution of the atmosphere, either by emanations from the contaminated water, or from flats, docks, banks of streams, etc.*

"*(c.) As to the effect of converting small streams into covered sewers.*

"*(d.) Any other facts that may occur to you.*"

Under this head 88 towns report, of which 42 appear to be more or less completely satisfied with this disposal of their sewage, while 46 regard it as objectionable and to be remedied as soon as possible. Lists of the two classes are subjoined. It will be observed that a few towns appear in both lists; *e. g.*, Fitchburg uses Nashua River as a receptacle for sewage without dissatisfaction, but is planning a

better method of dealing with Punch Brook; Somerville is satisfied thus to use Mystic River, but not Charles River or Alewife Brook.

From the following lists some idea may be formed in regard to the frequency and degree of pollution of streams and ponds in the Commonwealth. But it must be understood that these lists include but 169 of the 322 towns in Massachusetts, 153 having failed to report. Of the 19 cities every one made its return. The population of the places reporting amounts to 84 per cent. of the whole population. There would be no significance in indicating the population of each town on the lists, because we cannot in most instances state what proportion of the sewage gets into the stream in question. For convenience of reference another list is furnished in which the streams appear first, with the towns draining and sewering into each, so far as the writer has been able to ascertain from his line of investigation. It is evident that this danger is rapidly growing upon us, and that its future ratio of increase will be much greater; not only because population will become more concentrated, as well as actually greater, but because of a growing desire for aqueduct supply and its attendant "water-carriage" of sewage. It is gratifying to know that the objections to this fouling are felt in more than half the instances recorded, and that this fraction represents a very much larger proportion of the voters concerned.

Towns reporting Streams or Ponds used to receive Sewage to the SATISFACTION *of parties concerned.*

Towns.	Stream.	Source of Sewage.
Attleborough, .	"Ten Mile River," .	Certain factories.
Amesbury, .	Powow River,[1] .	Certain factories.
Athol, .	Small, swift streams, .	One-tenth of sewage.
Belmont, .	Two rapid brooks.	
Chicopee, .	Connecticut River, .	By way of canal and Chicopee River.
Clinton, .	Nashua River (South Branch).[2]	Gas and dye works.

[1] Has a good fall, and tidal wash. [2] Fish killed two miles below.

Towns reporting Streams, etc.—Continued.

Towns.	Stream.	Source of Sewage.
Easthampton, .	Manhan River.	
Everett, . .		
E. Bridgewater, .	Matfield River.	
Foxborough, .	Cocasset River, . .	Several factories.
Fall River, . .	"Fall River,"[1] . .	Twelve large factories.
Fitchburg, . .	Nashua River,[2] . .	Large part.
Great Barrington,	Housatonic River.	
Gardner, . .	Small streams.	
Hyde Park, . .	Neponset River, . .	Factories.
Hingham, . .	Tidal mill pond on town brook.	Small dye-house.
Ipswich, . .	Ipswich River,[3] . .	Manufactories.
Lowell, . .	Concord and Merrimac rivers.	Large part.
Leominster, . .	Monoosneck Brook, thence into Nashua R.	
Lancaster, . .	Nashua River, . .	One factory of shoe-shanks.
Lawrence, . .	Merrimac River,[4] . .	Many factories and some city sewers
Middleborough, .	Namasket River, . .	Manufactories.
Newburyport, .	Merrimac River to sea, .	Everything.
North Adams, .	"Rapid stream," . .	Everything.
Oxford, . .	"Stream," . . .	Woolen and cotton factories.
Palmer, . .	"Rivers," . . .	Factories and families.
Pittsfield, . .	Housatonic River, . .	Factories and a few tenements.
Stockbridge, .	Housatonic River, . .	Paper and "pulp" factories.
Shelburne, . .	Brook, and thence Deerfield River.	Factory, stables, etc.
South Hadley, .	Connecticut River, . .	Large factories and paper mills.
Sudbury, . .	"Stream," thence Sudbury River.	From two factories.
Tyringham, . .	"Small, rapid stream," .	Everything.
W. Springfield, .	Agawam River, . .	Mills.
Waltham, . .	Charles River, . .	Two factories.
Walpole, . .	Neponset River, . .	Factories and mills.
Ware, . . .	Ware River, . . .	Factories.
Warren, . .	Quaboag River,[7] . .	Six factories.
Westhampton, .	Brook, ...	One tannery.
Wrentham, . .	By Mill Brook into Charles R. in Medway.	"Two water-powers."
Wilbraham, . .	"Streams," . . .	"Manufactories."

[1] "Rapid fall to harbor."
[2] Close by city, river much discolored; no stench.
[3] "Nothing could be better."
[4] Large, rapid, and scoured yearly by freshets.
[5] Rapid river.

Towns reporting Streams (and Ponds) receiving Sewage to the DISSATISFACTION *of parties concerned.*

Towns.	Stream.	Source of Sewage.
Blandford, . .	Branch of Westfield R.,[1] .	Two tanneries.
Brookline, . .	Muddy Creek,[2] . .	Sewers.
Blackstone, . .	Blackstone River,[3] . .	One-fifth sewage.
Colrain, . .	Pond,[4]	Sewage of thirty families.
Charlestown, .	Mystic, Charles and Miller's rivers.[5]	Everything.
Cambridge, . .	Charles River and Alewife Brook[6]	Everything.
Chester, . .	W. Branch Westfield R.,	Tannery.
Concord, . .	Branch of Concord R., .	About one-twentieth.
Dover, . . .	Charles River, . .	Paper mill.
Dudley, . .	French River, . . .	"Some sewage."
Danvers, . .	Essex River (tidal), .	Gas factory.
Fairhaven, . .	Saltwater Pond,[7] . .	Sewage.
Foxborough, .	Cocasset River into Wading River.	"Many factories, etc."
Fitchburg, . .	Punch Brook,[8] . .	Much filth.
Groveland, . .	"Stream below fall" running into Merrimac R.[9]	Wash from wool and other factories.
Haverhill, . .	Merrimac and Little R's,[10]	Everything.
Hardwick, . .	Pond in Gilbertville, .	Mills.
Ludlow, . .	Chicopee River, . .	Partly through High Brook.
Lynn, . . .	Strawberry Brook, Stacey's Brook, Silver Lake, Flax Pond Marshes, Flats of harbor.	Everything.
Leominster, . .	Brook in N. Leominster,[11]	Tannery.
Lexington, . .	Vine Brook, . . .	Slaughter house.
Monson, . .	Brook, ...	Several woolen mills.
Middlefield, . .	Branch of Westfield R.,[12]	"One factory, two mills."
Natick, . .	Pegan Brook, thence to Lake Cochituate.	Factories, tannery, water-closets, dwellings.
Newton, . .	Charles River, . .	Manufactories.
Northampton, .	"Streams," thence into Mill River.[13]	
Orleans, . .	Sluggish tidal stream.	
Orange, . .	Pond, ...	Much sewage.
Plymouth, . .	Mill Pond,[14] . . .	Much sewage.

1 "Fish killed for half a mile below."
2 With tide-gate, increases pollution of "Back Bay."
3 Stench when river is low.
4 Stench and disease from the fouled banks in dry seasons.
5 Flats saturated with filth.
6 The former objectionable to Cambridge, Boston and Charlestown; the latter to Medford.
7 "Trouble expected."
8 Small stream through dense population, empties into Nashua River.
9 Much fouled.
10 Latter very bad.
11 For ½ mile offensive.
12 "Fish killed."
13 Filthy in droughts.
14 Offensive.

Towns reporting Streams, etc.—Continued.

Towns.	Stream.	Source of Sewage.
Peabody, . .	Procter's Brook,[1] . .	All kinds of leather factories; some dwellings.
Pittsfield, . .	Silver Lake by brook,[2] .	Factory.
Stoneham, . .	Mill Brook to Mystic head.[3]	Tanneries and 40 per cent. of town sewage.
Springfield, . .	Connecticut River, . .	Sewers.
Salem, . . .	North River; part of Mill pond.[4]	Worst kind, and in great amount.
Somerville, . .	Charles River, etc.,[5] .	City sewers.
Taunton, . .	Taunton River, . .	Sewers and factories.
Wakefield, . .	Saugus River, . .	Privies of rattan factory, 1,000 operatives at times.
West Brookfield, .	Large pond and Quaboag River.	
Worcester, . .	Blackstone River, . .	Everything.
Webster, . .	French River, . . .	All the factories.
Watertown, . .	Charles River, . .	All the factories, and town must drain same way.
Winchester, . .	Head waters of Mystic Pond.[6]	Five tanneries, a wool-washing place, and a number of dwellings.
Woburn, . .	Brooks emptying in head waters of Mystic Pond,[7]	Leather-shops, and much else.
W. Stockbridge, .	Shaker Mill Pond and Williams River.[8]	

[1] Discharges into North River in Salem.
[2] Ice-supply for the town; analysis shows brook and lake, near its mouth, to be perceptibly fouled.
[3] Horses will not drink waters; fish have disappeared.
[4] "A shocking and dangerous nuisance."
[5] In same category with Cambridge and Charlestown.
[6] A great amount of filth, and often offensive.
[7] Air and water fouled.
[8] Offensive at low water.

List of Streams and Ponds reported as receiving Sewage.

Streams.	Towns Sewering into.
Agawam River, . . .	West Springfield.
Alewife Brook, . . .	Cambridge.
Blackstone River, . . .	Blackstone.
" " . . .	Worcester.
Charles River, ...	Boston.
" "	Brighton.
" "	Brookline, through Muddy Brook, with tide-gate.
" "	Cambridge.
" "	Charlestown.
" "	Dover.

Streams.	Towns Sewering into.
Charles River,	Newton.
" "	Somerville.
" "	Waltham.
" "	Watertown.
" "	Wrentham, through Mill Brook.
Chicopee River,	Ludlow, through Higher Brook.
Cocasset River,	Foxborough.
Concord River,	Lowell.
" "	Concord, through branches.
Connecticut River,	Chicopee.
" "	East Hadley.
" "	Holyoke.
" "	Springfield.
Deerfield River,	Shelburne, through streams.
Essex River,	Danvers.
Fall River,	Fall River.
French River,	Dudley.
" "	Webster.
Housatonic River,	Great Barrington.
" "	Stockbridge.
" "	Pittsfield.
Ipswich River,	Ipswich.
Little River,	Haverhill.
Manhan River,	Easthampton.
Matfield River,	East Bridgewater.
Merrimac River,	Groveland, through stream.
" "	Haverhill.
" "	Lawrence.
" "	Lowell.
" "	Newburyport.
Miller's River,	Charlestown.
" "	East Cambridge.
Mystic River,	Charlestown.
" "	Everett.
" "	Medford.
" "	Somerville.
Nashua River,	Clinton.
" "	Fitchburg.
" "	Lancaster.
" "	Leominster, through Monoosneck Brook.
Namasket River,	Middleborough.
Neponset River,	Hyde Park.
" "	Walpole.
North River,	Peabody, through Procter's Brook.
" "	Salem.
Powow River,	Amesbury.
Punch Brook,	Fitchburg.
Quaboag River,	West Brookfield.

Streams.	Towns Sewering into.
Saugus River, ...	Wakefield.
Stacey's Brook, . . .	Lynn.
Stony Brook, ...	"
Strawberry Brook, . . .	"
Sudbury River, . . .	Sudbury, through streams.
Taunton River, . . .	Taunton.
Ten Mile River, . . .	Attleborough.
Vine Brook, ...	Lexington.
Ware River, ...	Ware.
Westfield River, . . .	Blandford.
" " West Branch,	Chester.
" " " "	Middlefield.
Williams River, . . .	West Stockbridge.

Ponds receiving Sewage, together with names of Towns which put them to such use.

Ponds — tidal. Names of ponds not given in returns, .	Fairhaven. Hingham. Salem.

Ponds—fresh.

Cochituate Pond, . . .	Natick, through Pegan Brook.
Flax Pond, ...	Lynn.
Little Pond, ...	Braintree.
Mystic Pond, ...	Stoneham, through stream.
" "	Winchester, through stream.
" "	Woburn, through stream.
Shaker Pond, ...	West Stockbridge.
Silver Lake, ...	Lynn.
Silver Lake, ...	Pittsfield.
Names of ponds not given in returns, ...	Colrain. Hardwick. Orange. Plymouth. West Brookfield.

In the report by Mr. Kirkwood will be found very valuable and full information in regard to the volume and character of the waters of the Chicopee, Blackstone, Taunton, Charles and Neponset rivers, including detailed accounts of the position and business of all manufactories on these streams and their tributaries, as well as the character and volume of their sewage. In the same paper there is contained so much information in regard to certain English streams, and their effect on populations using them as water-supplies, as to render it unnecessary to enter upon that comparison in this paper. And

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to this same report by Mr. Kirkwood (Part III. General Conclusions) the reader is referred for matter pertinent to the general question of pollution of streams and ponds by sewage.

There are three points, a clear understanding of which is so important to the public, that they may well be stated and emphasized again and again in this Report.

1. Chemical analysis, though a very valuable means of ascertaining the quality of water, is not alone sufficient. Especially it may fail to detect organic impurity in a water which is carrying the poison of typhoid fever or of cholera, an incredibly small amount of which is sometimes sufficient to set up the specific morbid action of those diseases in persons receiving said poison in their drinking-water.

2. A water-supply whose quality is *somewhat* deteriorated by the constant admixture of sewage, but not to such a degree as to lead the chemist to *condemn* it, or to cause distinct disease or increased death-rate among its consumers, may yet gradually and insidiously lower their vigor, so that when the time comes—as come it must in the case of streams which receive sewage from privies and water-closets—that some of the above-mentioned evacuations enter a water-supply, the zymotic poison then conveyed to the damaged constitutions of those using it will find them prepared to yield to the morbific influence, as the feeble and sickly everywhere succumb to disease which stronger and healthier constitutions resist successfully.

3. In cases where it may be impossible to discharge the sewage of a large town elsewhere than into the body of water furnishing the supply of the town, it should be strictly forbidden to discharge any *excrement* into the sewers.* Thus much can at least be effected, and it is the most important safeguard of all. It has been shown, under the head of "Excrement-Removal," that such exclusion is perfectly practicable and consistent with strict cleanliness and economy; and in the case supposed, a town might well forego the convenience of water-closets for the sake of safety from zymotic epidemics.

* The cases are probably very few, if there are indeed any such in our State, where *some* means cannot be devised of keeping all filth out of streams or ponds used for domestic purposes.

"*(a.) As to pollution of drinking-water.*"

The answers show that many correspondents misapprehended the scope of this question, and supposed it meant to cover every case of polluted drinking-water in their town; but, from data furnished by those who took the true meaning, it may be said that cases of such pollution as the question covers are rare, and that most of those which occur affect the drinking-water of other towns, rather than of that where the sewage *enters* the stream or pond. They may be looked for under Question IX.

"*(b.) As to pollution of the atmosphere, either by emanations from the contaminated water, or from flats, docks, banks of streams, etc.*

Nineteen instances of this kind are reported, all of which have already been given in the preceding lists, and the more important of which are detailed under special reports, or under III. and IX. It is worthy of notice that the evil in question is found almost entirely in the cities and large towns, where it is often very serious, and only to be remedied at immense expense; a fact which all growing communities may well note, and learn from it to take in hand their nuisances while yet manageable at moderate cost.

Many of these streams used as open sewers are most emphatically mentioned as being sources of very serious nuisance.

"(c.) *As to the effect of converting small streams into covered sewers.*"

Experience on this point is rare, there being but twelve instances reported, and the testimony of these seeming to conflict to some degree; but it is believed that closer examination would harmonize these discrepancies. This method is on trial at—

Chicopee, . .	Result	too recent to judge.
Everett, . .	"	favorable.
Lowell, . .	"	two inconsiderable instances; considered a bad practice.
Natick, . .	"	Pegan Brook for part of its course.
Newton, . .	"	perhaps favorable.
Peabody, . .	"	favorable on the whole.

Salem, . .	Result	very unfavorable.
Shelburne Falls,	"	favorable.
Springfield, .	"	unfavorable.
Wakefield, .	"	very unfavorable.
Woburn, . .	"	favorable.
Worcester, .	"	good, if enough flow of water at all times.

New Bedford reports Tripp's Brook as so treated, but it would seem rather to be a case where a small stream is run for a considerable distance ($1\frac{1}{8}$ miles) through well-constructed sewers, and before and after it enters these, is simply an open stream used as a sewer. The part of the city where it is in the latter state is thinly peopled, and the arrangement has been satisfactory. Pittsfield reports a similar case on a larger scale, with improvement to the health of the neighborhood.

In Salem, in 1874, there occurred a painful illustration of the dangers incident to the expedient now under consideration whenever it is carelessly adopted. As the whole story is given in detail in the Report of the Board for 1875 (p. 348), it is unnecessary to repeat here more than its main features, viz.: For about half a century a small water-course had been used as a drain and sewer for certain streets; and, as it traversed many back yards, and passed directly under one dwelling, it was walled and covered as suited the ideas of each householder,—with stone, with wood or with both, always loosely built,—that it might the better serve the purpose of a drain. On Norman Street (nearly a quarter of a mile from its beginning) it turned a right angle as it passed between two dwellings three feet apart, and there (after remaining open for many years), it was, about twenty years ago, covered by the city with plank at the petition of the abutters. On the decay of the plank, it was re-covered with flagstones, having loose joints. The bottom of the drain at this point was a foot below the earthen floor of the cellars. The *cellar walls of loose stones formed its sides.* Its covering was hardly concealed with earth. In the course of time, the streets above Norman Street were supplied with proper sewers, and it was proposed to continue the trunk line down Norman Street, but the city would not assume the whole expense, and the abutters were unwilling to be assessed on its account. For "economy," therefore, all the sewage and drainage from

the new sewers above was made to enter the "small stream, converted into a covered sewer," as above described. The outlet of the sewer being "tide-locked," the gases were, at certain hours of each day, under strong outward pressure, and escaped freely between the loose covering-stones. Upon complaint from the tenants of the two houses between which the rectangular turn occurs, the city cemented the loose joints of the covering, a proceeding which could result only in forcing sewer-gas in greater quantities through the loose cellar walls which formed the sides of the sewer. Then came the death of the son and daughter of the tenant of one of the houses. Upon this, the city lined the interior of this cellar wall with brick and cement, but did nothing to the floor; and at the time of reporting, in 1874, no steps had been taken toward laying a proper sewer in the street. This has now been done, however.

Since the time, in 1869, when the flow from the new sewers above was turned into the Norman Street water-course, and up to date of reporting, in 1874, twelve cases of typhoid fever occurred within two hundred and fifty feet of this "water-course converted into a covered sewer."

With this instance from one of our oldest cities, may be compared the following account from the correspondent of the board in Wakefield (formerly South Reading) :—

"A 'covered stream used as a sewer,' in our town, is so much a sewer, that it is doubtful if it ought to be called a stream, unless it be a stream of filth,—a very grievous source of danger, disease and discomfort, not easy to deal with, almost impossible to abolish, except at great expense, and not lessening, but increasing, with growth of population. The stream was originally the product of the gathered waters of quite a little water-shed, which, finding a boggy basin at the head of the little 'run' through which the stream passes, undoubtedly in the early days 'ponded' there, and made a swamp spot, whose weep and overflow gradually worked its way down this little ravine, a clear rill, receiving the land-wash as it went, till it met, as now (only then comparatively pure), the outfall stream of Crystal Lake, within a rod or two of our present Centre Depot, and commingling with that passed on through the meadows to Saugus River. The little swampy basin that was the 'head waters' of this stream, chanced to fall within the purchase of a

wealthy gentleman, who dug it out, and stoned it about for a fish-pond, and drained into it the surrounding land.

"This pond is now the principal source (secondary) of this stream, (of course the land side was and is the original); and across the stream, after it leaves the pond, there have been thrown four streets, while three stables have been built *over* it in its course, and it is now (beside the streets and buildings) covered in its passage through private grounds for a distance of nearly one-eighth of a mile. It was formerly covered through private land some forty or fifty rods more, but its stoned-up walls caved in, being too narrow bounds for its frequent volume, its leach became a general nuisance, demanding attention, and it was finally reopened and increased in width, and now remains open. Where now closed it has been covered with flag-stones, and from a foot to three feet of earth.

"The stream not only surface-drains quite a large and very populous area, but receives, for its length, a very large number of ditches, drains, cesspool overflows, stable-cellar leachings and vault-soakages, beside the street-wash, hogpen-filth, etc., of its 'line of march.'

"When on the board of health two years ago, I made a careful study of the stream, and endeavored to devise plans whereby its dangers and annoyances might be at least mitigated. All I could do was to remove, so far as possible, all incoming sources of filth, as hogpens, privy-vaults, sink-drains and swill from immediate contact, though, as you will readily perceive, I could not but recognize that the removed privy-vaults, etc., would soon send their contents percolating through the small amount of intervening soil to the stream again.

"Wherever the stream has been covered, it has frequently clogged and 'backed up' into drains and yards, forcing its gases into such houses as were connected by tight pipes with it, and making a general nuisance. On my formerly frequent night rounds, as health officer, the line of this stream almost always greeted me with a cloud of dank moisture, and occasionally with a mouldy, sickly smell, like that of some of the fungi. I have ever regarded it as one of the chief agents of disease in our midst, and have taken some pains to ascertain in regard to the health of its adjoining neighbors during the last five years."

A specimen from this brook sent for analysis was very foul throughout. It is shown by the following table to be very largely contaminated with filth; much more so, indeed, than many specimens of sewage examined by Prof. Nichols for the Fourth Report of the State Board of Health.

	Results expressed parts per 100,000.
Ammonia,	0.3600
"Albuminoid ammonia,"	0.2000
Inorganic matter,	49.28
"Organic and volatile matter,"	9.40
Total solid residue at 212° Fahr.,	58.68
Chlorine,	6.04

It is interesting to compare with the experience of Salem and Wakefield that of Peabody (formerly South Danvers), where, for many years, a vast amount of sewage of the worst description has been poured into a stream traversing the very centre of the town, covered for considerable distances at several points, and making some sharp turns in its course. The walls of this stream converted into a sewer are in some places formed by the foundations of buildings. There is a distinct stench from it, but this is never made a ground of complaint to the local authorities. In the experience of a physician in active practice there for more than a dozen years, and in that of his father also, who for at least a quarter of a century practised medicine there, no especial prevalence of disease of any kind has been observed in the many dwellings and business buildings along the course of this polluted stream. The explanation of this is to be found in the volume and constancy of the stream, in the size and openness of its bed (for even along its covered portions air circulates freely), and in the attention paid to prevent accumulations of filth in its course. It is cleansed twice a year. Something may be attributed to the various astringents and mineral disinfectants pouring in with the sewage, but these are of no avail in the neighboring city of Salem, and must exert in Peabody an influence much inferior to that of the causes just enumerated. It will be observed that split-granite and mortar—not loose-jointed stones—form the foundations of the few buildings which wall the stream.

A detailed description of this brook, and the evils incident

to its pollution, are given in the following extracts from the replies to our circulars.

Account of Procter's Brook in Peabody.

"A few families, near a brook which divides the town nearly equally as to population, etc., lead their drains into it. This brook is the natural sewer of the town, and without it the principal industries of the place could not be carried on. It answers its purpose admirably well, for even in the driest weather there is always a sufficient flow of water to keep the channel clear. It flows through all the settled portion of the town, in a stone-walled brook, about fifteen feet wide, partially covered, and partially open; is crooked in its course, and is made to turn several right angles in the very centre of the town. The sewage of manufactories is discharged almost entirely into this brook. These manufactories consist of between twenty and twenty-five tanneries, three glue factories, seven morocco factories, and one bleachery of cotton cloth. The sewage from the tanneries and the morocco factories is mainly the water from the 'soaks,' so called, or vats in which the raw hides, skins, etc., are washed and softened. This water necessarily contains much putrefactive matter, and is strong-smelling, but some disinfecting power is exerted by the lime which is used, and which also is poured into the brook.

"The sewage of the glue factories is deprived of the most of its solid constituents, and when it reaches the brook it consists of very dirty-looking and strong-smelling water. Fortunately, the bleachery, which is situated just below the glue factories, pours into the brook large quantities of copperas, logwood, cutch, gambia, chloride of lime, etc., in solution, which, though discoloring the water, do not render it offensive to the smell. On the contrary, it has been remarked that the brook below the bleachery is not so offensive as it is above, where it is fouled by the sewage of the glue factories, as above stated.

"It will be seen that this brook contains considerable putrefactive matter, and in hot summer days the smell is certainly offensive near its course. That it is not more so is accounted for by the facts that it is a constantly moving current, and that much disinfecting and deodorizing material is also circulating in its waters. Twice a year, too, when the water is low, the local board of health have its channel raked over, and then flushed from the dam above, near the bleachery. It is checked in its course at several points, as above at the bleachery, and principally again at Frye's mills in Salem. The effect of this latter dam is to overflow into a pond of some acres the

low lands extending for an eighth of a mile above. It is here that the major part of the solid material must be deposited; yet it is the testimony of near residents that no odor is perceptible, except at such times as the water has been run off, as is occasionally done, leaving the bed of the pond naked. Below this dam extensive tanneries and other manufactories, as well as some of the Salem city sewers, empty their sewage upon flats, which, when bare at low water, emit a stench in hot summer nights which is carried to points at considerable distance, and over a thickly settled portion of the city of Salem.

"In answer to Question IV. (Is such sewage often or strongly offensive?), it may be said that to occupants of houses situated directly on the borders of the brook or canal in its course through the town of Peabody, the odor arising from it during the summer months is offensive, and sometimes strongly so; and yet, as a member of the local board of health for seven years, I do not recollect of a single complaint; very possibly because it has been looked upon as a necessary evil. The smell, however, cannot be carried very far, as it never has been perceptible in my own residence, though the latter is situated within three or four hundred feet of an open portion of the brook.

"I think there are no wells used for domestic purposes within such proximity to the brook as to incur the danger of contamination."

In answer to certain questions, the following additional information was furnished:—

"The walls of the stream, or streams, passing through Peabody are stoned up with rubble-stone, mostly, though in some places split-granite has been used, but no mortar, except where, as in some cases, the foundation of a building forms the wall of the channel.*

"There are several places in the course of this stream where buildings have been erected immediately over its course, and one is used as a boarding-house, in which are a dozen or more boarders. No unusual sickness ever occurred in the house, to my knowledge.

"Below Grove Street, a large space is overflowed by water, and forms the pond mentioned in my report. At the present writing, it has been run off, and I see the bed of the stream is very black and foul."

From considerations of convenience and decency, the change from the open to the covered condition of small

* Compare the map of Salem and Peabody, page 259.

streams which are constantly receiving offensive sewage, is pretty certain to occur, and it is therefore of great importance that the sanitary aspect of the change should be familiarly known. It may be stated as follows:—

All the unwholesome conditions existing in open streams polluted by sewage remain unchanged when such streams are simply covered, or when they are covered and walled with material of an absorbent or permeable character—as wood, brick or stone, without good cement. They even become more dangerous as generators and conductors of sewage-gas, because they admit air far less freely; consequently their gases are less diluted and more poisonous. At the same time, being less conspicuous, or even out of sight, they may insidiously deliver their poisonous gases within dwellings, or in close neighborhood to windows. And further, such streams, even if suitably covered and walled, may, if their bottoms are left unchanged to absorb and at the same time to retain the commingling sewage, continue to contaminate the earth through which they flow, with the effect of polluting all neighboring wells, and rendering the soil along their banks unsafe foundation for dwellings. The transformation into "covered sewers" can be made safely only by changing them into *complete* sewers. In this case, great care must be taken that proper drainage of the soil is also maintained. Whenever the demands of an increasing population require that streams should be converted into sewers (an evil which should be avoided, if possible), it is not often possible for a single conduit to serve both purposes of sewer and drain. The only thoroughly satisfactory method is to have a tight sewer for the sewage, and beside that a loose-walled drain to carry off the moisture from the soil.

The following account, from Chicopee, shows the benefit which may, in some cases, arise from converting into a well-built sewer a stream which had become so fouled as to be practically simply an open conduit for sewage:—

"On the south-east border of our village is an elevated ridge of land, the water from which nearly all gathers into a water-course which runs across the south-westerly portion of the village, into the Connecticut River, a short distance below its junction with the

Chicopee. In this course it runs through an open square or 'common,' about fifteen rods across, which is bounded on all sides by dwelling-houses, standing so near each other that there is but one chance of putting in another. This water-course, a large portion of the year, had more or less water running in it. In the very driest season it would occasionally be partially dry, but nearly always muddy, even then. In spring, or wet weather, quite a brook ran through the course. Last summer the whole was made into a brick sewer, apparently substantially built. This sewer formerly was covered through part of its length only, and was left open for some fifteen or more rods through a sort of ravine, before reaching the Connecticut River. Many complaints were made about this open piece of sewer, and I have no doubt much sickness was caused by it. At the time the water-course was converted into a sewer, with brick walls, this open tract was also built up and covered, and the ravine was cleared of pigpens, and all other sources of filth, except privies. Blocks of tenement-houses now occupy each side of the ravine. I have little doubt that this improvement has conduced very much to the health of the population in this neighborhood, as we have had less fever, dysentery and spinal meningitis, etc., than in any autumn for many years. The sanitary conditions of this section are so far very satisfactory. While fever and diphtheritic diseases have prevailed in towns adjoining us, we have been remarkably exempt all through the present autumn."

"QUESTION VIII.—*Have you in your town (or city), damp or wet cellars?*"

One hundred and twenty-eight towns report many damp or wet cellars; ninety-seven find this condition productive of disease; thirty-one do not.

The class of diseases most frequently noted in connection with such cellars is "inflammatory diseases of the respiratory organs" especially bronchitis. Next in order of frequency comes rheumatism, more particularly of the sub-acute order. Phthisis, pneumonia, and wasting chronic perversions of digestion are also found by many of our correspondents to be common over such cellars. Also a lessened power of resistance to all diseases when contracted. No observer can doubt that a large amount of preventable disease is caused by damp cellars. The remedy for this evil is admirably set forth in a paper on "Drainage for Health" by Hon. H. F. French.* A good

* Fourth Report of the State Board of Health, p. 182.

system of sewerage very generally cures the evil, and no town which has reasonable expectations of ever needing sewerage should allow any dwelling to be built at an undrainable grade. How many cities in Massachusetts are groaning to-day under the evils and expenses brought upon them by the short-sighted policy of permitting such cellars to be made.

Even where population seems destined to remain small and widely scattered, public opinion should insist on the necessity of good drainage for every dwelling. No town can afford to have house after house built with no provision for keeping the ground beneath it dry, and so far maintaining the health and producing power of its inhabitants. If we had enlightened local boards of health, ordinances would soon become common which would require that every new dwelling should be examined and approved by a health official as to this requirement of drainage, before it could be inhabited. The expense of securing proper drainage is small—except in localities altogether unfit for habitations—and the return in exemption from disease is unspeakably valuable.

In some of the very low-lying towns of the State, drains are very much needed to relieve large tracts of land, including many dwellings, from the excessive soil-moisture. Individual action in these cases is generally of little avail, and the only effectual remedy is in the construction of proper drains by the town authorities.

"QUESTION IX.—*Do you know of any case where the sewage of one town pollutes the air or water of another? If so, please state circumstances.*"

In answer to this question, fifteen cities and towns replied in the affirmative.

In Wakefield, the filth discharged into the brook running through the town, finally finds its way, at least a considerable portion of it, into the Saugus River, from which Lynn has proposed taking part of its water-supply.

Our correspondent in Natick says that "the sewage of Natick must soon seriously pollute the water-supply of Boston."

The banks of the Sudbury River, above the point from which the supply for Boston is to be taken, need protection

with reference to preventing any pollution, which otherwise must inevitably occur.

In the Mystic water-shed, there are serious evils which will be pointed out in detail at a later page.

The Merrimac River, above Lowell, is polluted by the sewage of Manchester, and of several smaller towns in New Hampshire; before reaching Lawrence, the sewage of Lowell, and a considerable amount of filth brought down by the Concord River, have been added. Haverhill, still lower down, gets the benefit also of the sewage of Lawrence, together with the refuse discharged into the Merrimac by the Shawshine and Spicket rivers, the latter of which, in summer, is rendered quite offensive by the filth from manufactories. The cities on the Merrimac River have not yet introduced complete sewerage systems. The volume of the stream, too, is so great, and its current is so rapid, that the impurities in the river just above Lowell, Lawrence or Haverhill are hardly appreciable to the chemist. Mr. Henry F. Mills, C. E., of Lawrence, says: "The Merrimac River flows through the middle of the territory of the city, with a quantity of water varying yearly from 60,000 cubic feet of water per second, with an occasional year increasing to 90,000 cubic feet per second. The water falls here about thirty feet. Below the dam, where all sewage enters, the banks of the river are covered with silt or fine sand to the depth of a foot or more, during heavy freshets; and, as the surface of the water settles with the decrease in the quantity of water, this new lining of the bed is carried away. Thus, there is a continual renewal of the bed of the river from season to season; that is, a deposition and its removal without materially changing the level of the bed from year to year. The result is a clean river-bed and banks at all times. The Spicket and Shawshine rivers discharge—say, one-hundredth of that of the Merrimac; and no deleterious effect, that I am aware of, is noticed from the small amount of sewage discharged into these streams."

In all of the three cities just mentioned, the discharge of sewage into the river is at points considerably below the source of water-supply. Lowell and Lawrence have large filtering-galleries; the water used in Haverhill comes chiefly

from three ponds in the vicinity of that city. Still, in at least Lowell and Lawrence, the inhabitants are more or less dependent directly upon the river for the water which they drink; and the amount supplied to them for domestic purposes from this source, is likely to increase from year to year, while the relative pollution of the river must increase at a still more rapid rate, unless special provision be made to prevent it. At Haverhill, the lowest point in the river to which we have referred, there is no contamination of the Merrimac appreciable by the unaided senses, except at the mouth of Little River. The water taken just above the city supplies those of the inhabitants who live on high land. It is considered of very good quality.

Newton, Waltham and Brookline have built large reservoirs near the Charles River, from which they get their water-supplies. When such reservoirs were first planned, it was thought that by being placed near rivers they would be supplied by them, and that the intervening walls of sand and gravel would serve as extensive filter-beds to remove any impurities which might exist. It has been found, however, that the water of such reservoirs is probably supplied chiefly by deep springs or underground streams running toward or parallel to the rivers. This theory is upheld by the following facts:

I. Chemical analysis shows in such cases that the water of the reservoirs contains a very much larger proportion of inorganic matter than that of the adjacent river.

II. The temperature of the water in the reservoirs remains quite constant throughout the year, while that of the river varies from twenty to thirty degrees between summer and winter.

III. Although the water in these reservoirs maintains a level not very different from that of the river, still the two are not so nearly alike as to lead us to suppose that the one is wholly dependent on the other.

It is more than probable, however, that some water passes from the river into such reservoirs,* and, it is therefore pru-

* Dr. F. de Chaumont, conjoint professor of military hygiene at the Army Medical School, Netley, concludes from his experiments and analyses of water in the vicinity of the River Hamble, that, if sewage is poured into a stream, it will, in a porous soil, contaminate the neighboring wells. Much more, of course, would it affect the water of reservoirs quite near the banks.

dent to guard such streams with a considerable care. In this connection, it is appropriate to quote from a recent report by Drs. Swan, Wood and Bowditch.*

"The water-supply should be 'incontaminable by drainage.' There is no demonstrable safety in a middle course. No one has conclusively shown that it is safe to trust to dilution, storage, agitation, filtration or periods of time for the complete removal of disease-producing elements, whatever these may be. Chemistry and microscopy cannot and do not claim to prove the absence of these elements in any specimen of drinking-water. They discover pollution; and pollution is somehow intimately associated with the production of certain diseases. Our germ, fermentation and other theories indicate our actual ignorance of the ultimate nature of that cause or those causes whose action we nevertheless rightly infer. These deductions from the observations of cases and their surroundings have been so often repeated that we cannot afford to disregard them. Chemistry in these cases has been invaluable in pointing out the fact and source of contamination; but it has not indicated the quantity and quality of the specific cause."

With reference to the pollution of the air of cities or towns by the filth discharged above them, Worcester, Peabody, and the cities comprising the metropolitan district of Boston furnish the most conspicuous examples. As to the amount of disease caused in this way, our correspondents naturally speak with some caution. That fresh air and fresh water disinfect beside diluting, cannot be gainsaid; and it is chiefly among dense populations, or where the poison is very concentrated, that we should naturally expect evil results from this source. That filth-infection of the air seriously depresses the vital powers, and that it is one of the chain of causes producing epidemics, are matters of common observation.

Reports from Various Localities.

In many cases the information which has been got from the different cities and towns illustrates general principles so well, that somewhat detailed statements are given from some of the replies of our correspondents. The writer has also person-

* Report of the Medical Commission upon the sanitary qualities of the Sudbury, Mystic, Shawshine and Charles River waters. (City Doc., No. 102, Boston, 1874, pp. 12 and 13.)

ally examined many of the localities referred to, and has added his own notes.

*Boston.**

"I. Boston is supplied with water from four sources, Lake Cochituate, Mystic Pond, Jamaica Pond and the Sudbury River.

* In the Metropolitan District are included Boston and many of the neighboring cities and towns, which, though at present distinct, are so connected in many ways, that they are likely at no very distant day to be joined under one city government. They are, therefore, and for convenience' sake, all represented on the accompanying map. A table of statistics, prepared by E. R. Howe, C. E., is also given, as follows :—

City or Town.	Area.			Miles of Streets.	Dwellings.			Population.
	Upland—Acres.	Low and Marshy Land—Acres.	Total, not including Streets—Acres.		Occupied.	Unoccupied.	Total.	
Boston, ...	8,810	10,635	19,445	430	40,817	1,931	42,748	341,919
Brookline, ...	3,500	500	4,000	37	1,065	30	1,095	6,675
Cambridge, ...	2,415	1,045	3,460	75	7,238	531	7,769	47,838
Somerville, ...	2,312	443	2,755	73	3,562	406	3,968	21,868
Everett, ...	1,450	650	2,100	17	700	70	770	3,651
Chelsea, ...	406	620	1,026	45	3,517	314	3,831	20,695
Revere, ...	2,100	1,300	3,400	16	246	36	282	1,603
Winthrop, ...	697	185	882	10	123	22	145	663
Totals, ...	21,690	15,378	37,068	703	57,268	3,340	60,608	444,912

City or Town.	Water.					Total Length of Sewers.
	Daily capacity of Water-works—Gallons.	Average Daily Consumption—Gallons.	Houses supplied.	Business places supplied.	Sources of Supply.	
Boston, . .	64,000,000[1]	18,500,000	30,036	14,640	Cochituate Lake, Sudbury River, Mystic Pond, and Jamaica Pond, . .	160[2]
Brookline, .	6,000,000	500,000	200	150	Charles River, wells, etc.,	3[3]
Cambridge, .	8,000,000	3,000,000	9,695	1,724	Fresh and Spy ponds, .	40[4]
Somerville,		1,500,000	2,796	355		14[5]
Everett, .	12,000,000[5]	250,000	375	45	Mystic Pond, . . .	-
Chelsea, .		1,250,000	2,985	566		17[7]
Revere, . .	-	-	-	-	Wells, etc., . . .	-
Winthrop, .	-	-	-	-	Wells, etc., . . .	-
Totals, .	90,000,000	25,000,000	46,087	17,480	. . . . . .	234

[1] Including Mystic;—that is, the *possible* supply from all sources when the works are completed.

[2] Discharged into Charles and Mystic rivers, Boston Harbor, and Back Bay.

[3] Discharged into Muddy Creek and Charles River.

[4] Discharged into Charles River and Alewife Brook.

[5] Mystic Pond.

[6] Discharged into Mystic, Charles, and Miller's rivers.

[7] Discharged into Chelsea Creek and Mystic River.

"*Lake Cochituate* lies in the towns of Natick, Framingham and Wayland. It virtually consists of three lakes or ponds; in all, three and one-half miles long, three-eighths of a mile wide, and sixty-two feet deep in the deepest part. At high water, its area is eight hundred acres, though ordinarily only six hundred and ninety. Snake Brook enters it near the gate-house, and Farm Pond is connected with the lake at the south-east end by means of Beaver Dam Brook. The waters of Dug Pond (forty-two and one-half acres) and of Dudley Pond (eighty-one acres) are also used as feeders to Lake Cochituate. Pegan Brook, containing some of the drainage of Natick, also flows into the lake at its lower end.

"*Mystic Pond* was formerly at the head of tide-water. The upper pond has been separated from the lower by a dam, and is the source of supply. It is one mile and a quarter long (including the flowage pond at its head), and a half-mile wide. At high water, it is eleven feet deep, has an area of two hundred and thirty acres, and a capacity of forty-five million gallons. The Mystic water-shed, exclusive of the lake itself, has an area of twenty-seven square miles, including the towns of Winchester and Woburn, with portions of Arlington, Lexington, Burlington, Wilmington, Reading and Stoneham. Horn Pond, Richardson's and Burbank's ponds, in Woburn, and Wedge Pond, in Winchester, are directly connected with Mystic Pond by means of the Abajonna River, and are the sources of direct supply to the lake.

"The available storage capacity of Mystic Upper Pond is about three hundred and eighty million gallons; so that, if all the storage facilities above the pond be used, a total daily supply of seventeen million gallons may be obtained in a dry season. The average amount used daily now is about eight million gallons. It is distributed to the cities of Somerville and Chelsea, and to the towns of Everett and Revere, as well as to the Bunker Hill and East Boston districts of Boston. This system is also connected with the Cochituate main, to be used in case of necessity.

"*Jamaica Pond* is situated in West Roxbury, fifty feet above low-tide level, and has a surface area of sixty-seven acres. Its water-shed contains about four hundred and forty acres in West Roxbury and Brookline. It has a capacity of supplying one million gallons daily, although it is not all now made available. One hundred families in Brookline, and eleven hundred in wards thirteen, fourteen and fifteen, of Boston, get their water from this pond. The distributing system, introduced in 1840, was by gravitation only; but, that being now insufficient, a stand-pipe with pump has just been erected, with a capacity of distributing one million gallons daily, and to the tops of the highest houses.

"*Sudbury River* was temporarily connected with Lake Cochituate by an open ditch to Farm Pond, during the drought of 1872. This was again done in 1874. Arrangements have been made for a permanent conduit. The daily supply which may be relied upon from this source will be forty million gallons.

"The following table shows the comparative examinations of the sources of water-supply for Boston. (See pp. 236–239.)

"We have no statistical information by which we can say precisely what the effect of the introduction of water has been upon the health of the community. Cochituate water was first introduced in 1848, and sewers had been then built over thirty years. There is reason to suppose that our returns of deaths in the city are not to be depended upon, previous to 1849; in fact, that they have never been kept with completeness until the Board of Health began a system of accurate registration, last May. The late Dr. George Derby, however, from carefully prepared data, concludes that typhoid fever has diminished.* The water of Cochituate has, probably, not yet been contaminated to a serious degree, but the sewage and drainage of Natick must furnish a cause of some uneasiness to those who drink the water. It has been thought that the filth poured into Mystic Pond affected the health of the people supplied by it, and that, in 1872, the mortality, especially among infants, sensibly increased, owing to the impurity of the water-supply.†

"II. (*a.*) Owing to the peninsular shape of Boston proper, the sewers follow, to some extent, the natural channels for getting rid of the storm and other waters; and no *system* came into use until after the introduction of water in 1848. Then the lines were short and the grades sharp, and the sewage generally found ready outlets. Large tracts of made land, however, have been added to the original peninsula, increasing its area from 690 to 1,570 acres. The grade of this land has been low, never more than eighteen feet above low-water mark (or eight feet above the level of high tide). Some parts were originally only twelve or thirteen feet above tide at low water. Consequently, the sewers have necessarily been elongated at almost flat grades, and serve to deposit a large part of the sewage instead of carrying it off.

"II. (*b.*) There are two evils in our sewerage system:

"1st. The sewers do not discharge readily, thereby causing obstructions in house-drains, forcing sewer-gases into the houses, rendering the cellars damp, and incompletely draining the soil.

"2d. They discharge by several dozen outlets, completely skirting

* Second Annual Report of the State Board of Health, p. 126.

† Sixth Annual Report of the State Board of Health, pp. 335 and seq.

the city, contaminating the air very widely, and, in some places, rendering it absolutely unfit to breathe. The system, therefore, has been very generally complained of for several years. A special commission has investigated and reported upon the subject. The plans which they recommend are given in the accompanying map.

"II. (c.) As stated above, the sewage is discharged upon large areas of flats or into the docks in the majority of cases, and there can be no doubt of its baneful influence upon the health of the community.

"The sewage of the north part of the city is discharged by a large number of independent sewers, radiating from the high land in the centre. In this part of the city, probably, the injury to health is greater from bad house-arrangements than from the sewers themselves, bad as they, in some cases, are.

"The low made land at the western and southern sides of the city drains partly into the South Bay and partly into Charles River by sewers, which are, most of them, tide-locked and very flat. They are intended to be large enough to serve as reservoirs in case of heavy rain, when the discharge is prevented by a high tide. This prevents the soil from being properly drained; soil-moisture is one of our greatest evils, and consumption causes nearly one-sixth of our total number of deaths each year. Our enormous infant mortality, too, has been attributed partly to this dampness of the soil and partly to the general contamination of the air. In consequence of this failure of the sewers in always discharging their contents speedily, we have many damp, wet and flooded cellars; but many of them, especially at the South End, are below the grade established by the statutes (twelve feet above low-water mark), the law being often disregarded.

"The drainage of Charlestown, East Boston, and South Boston, as will be seen by referring to the map, has many of the faults of the city proper.

"Roxbury is drained partly into the upper end of the South Bay, and partly by the Stony Brook sewer on to the flats beyond Parker Street, a certain proportion of the sewage finally finding its way into the Charles River. With the exception of a small part of Dorchester, which drains into the lower part of the Neponset River, there are few sewers in the outlying wards of the city. In the whole city, including all wards, there are about one hundred and sixty-six miles of sewers.

"III. There are some houses of the poorer class in the thickly settled parts of the city in which no water-closets are used; the liquid part of the house-refuse runs off into the sewers, leaving the solid contents of the privies to be removed by carts.

[See page 240.

Examination of the Water-Supplies of Boston.

[Results expressed in Parts per 100,000.]

JAMAICA POND.*

Date.	LOCALITY.	Ammonia.	"Albuminoid Ammonia."	Solid Residue. Inorganic.	Solid Residue. Organic and Volatile.	Solid Residue. Total at 212 deg. Fahr.	Chlorine.	Remarks.
Nov. 22, 1875,	Six feet below surface, opposite ice-houses of Jamaica Pond Ice Company, ...	0.0040	0.0140	4.16	1.64	5.80	0.70	This water has almost as good a quality as that of Lake Cochituate. The greater amount of chlorine found in it may be largely due to its being so much nearer the sea. There is perhaps, too, some slight indirect drainage from the neighboring population.
	Same point, 12 feet below surface, ...	0.0048	0.0152	3.92	1.56	5.48	0.68	
	Near gate-house, one foot below surface, . .	0.0036	0.0136	4.00	1.64	5.64	0.69	
	Same point, six feet below surface, at bottom, .	0.0040	0.0128	4.32	1.68	6.00	0.67	
	Mean of filtered, .	0.0041	0.0139	4.10	1.63	5.73	0.68	

SUDBURY RIVER.†

Sept. 24, 1874,	Whitehall Pond, . .	0.0106	0.0248	2.0	2.6	4.6	0.30	Except where contaminated by mills, sinks, pigsties, privies, etc., "the water has an excellent composition." [Report of the Medical Commission upon the sanitary qualities of the Sudbury, Mystic, and Shawshine rivers waters, p. 44.]
24, "	Cold Spring Brook, . .	0.0052	0.0150	3.8	1.8	5.6	0.50	
25, "	Angle Brook, below Marlborough, . . .	0.0016	0.0104	7.6	5.4	13.0	2.70	
25, "	Angle Brook, at Dam No. VII., ...	0.0010	0.0090	4.6	2.4	7.0	0.70	
25, "	Stony Brook, . . .	0.0010	0.0190	3.8	3.0	6.8	0.50	
24, "	Sudbury River, at Cordaville, ...	0.0090	0.0270	3.6	3.8	7.4	0.45	
5, "	Sudbury River, above Ashland, ...	0.0020	0.0310	4.2	1.8	6.0	0.80	
5, "	Sudbury River, below Ashland, . . .	0.0034	0.0360	4.8	3.4	8.2	1.20	
2, "	Sudbury River, . . .	0.0016	0.0290	3.6	3.8	7.4	0.80	

* Analyses by Prof. W. Ripley Nichols.

† Analyses by Prof. W. Ripley Nichols, from Fifth Annual Report of the State Board of Health.

Examination of the Water-Supplies of Boston — Concluded.

MYSTIC POND.*

Date.	LOCALITY.	Ammonia.	"Albuminoid Ammonia."	Solid Residue. Inorganic.	Solid Residue. Organic and Volatile.	Solid Residue. Total at 212 deg. Fahr.	Chlorine.	Remarks.
June 13, 1873,	Bacon's Bridge,	0.0133	0.0280	8.00	2.85	10.85	2.12	The contamination of this water-supply by Russell Brook and the Abajonna River, is quite evident.
13, "	Bacon's Bridge,	0.0136	0.0251	9.00	2.50	11.50	2.00	
13, "	Bacon's Bridge,	0.0135	0.0216	8.20	1.30	9.50	2.00	
13, "	Bacon's Bridge,	0.0133	0.0229	8.50	1.50	10.00	1.96	
	Mean of the above four,	0.0134	0.0244	8.42	2.04	10.46	2.02	
June 16, 1873,	Horn Pond outlet,	0.0076	0.0181	4.90	1.50	6.40	1.24	
16, "	Russell Brook,	1.9120	0.1800	52.50	7.70	60.20	23.60	
16, "	Russell Brook,	1.7000	0.2000	55.70	5.00	60.70	24.80	
-	Abajonna River,	0.0266	0.0207	8.50	1.70	10.20	1.45	
-	Abajonna River,	0.0273	0.0241	8.30	1.50	9.80	1.60	

LAKE COCHITUATE.†

July 4, 1873,	Massachusetts Institute of Technology, . . .	0.0033	0.0120	2.84	2.80	5.64	0.34	This water has usually been of exceptional purity.
Sept. 6, "		0.0040	0.0120	2.76	2.06	4.82	0.30	
15, "		0.0033	0.0120	2.40	1.90	4.30	0.31	
Oct. 6, "		0.0033	0.0120	3.24	1.96	5.20	0.34	
25, "		0.0034	0.0080	2.36	2.40	4.76	0.32	
Nov. 15, "		0.0033	0.0132	3.00	2.00	5.00	0.30	
Dec. 19, "		0.0037	0.0100	3.32	1.28	4.60	0.34	

* Analyses by Prof. E. S. Wood.

† Analyses by Prof. W. Ripley Nichols, from Fifth Annual Report of the State Board of Health.

"In the outlying parts of the city, cesspools are generally used. A few of them are also to be found in some of our oldest streets. In some of the new wards, under the demand to have an abundant supply of water, the water-pipes have been introduced without sewers, an evil which will probably be soon remedied.

"IV. The sewage discharged near Prison Point in Charlestown, at Craigie's Bridge in Somerville, on the flats of East Boston, into the basin at the outlet of Stony Brook, at the Roxbury Canal, and on the flats of the Charles River near Beacon Street, has been for years the source of the greatest complaint. It is spread out over many hundred acres of impervious mud, and under a summer's sun is productive of emanations which have often been so vile that workmen have even been obliged to leave their vicinity.

"V. There are very few wells in Boston which are now used. Those few, however, must be looked upon with suspicion, for they are, almost without exception, exposed to danger. The sewage of Boston does not pollute any source of water-supply, except wells.

"VI. Serious discomfort has been frequent. It has been possible, in a certain number of cases, to trace disease, especially diphtheria and a low type of fever, to putrefactive changes in the sewage close to some of the tenement-houses. It is a well recognized fact, too, in our city, among physicians, that disease often assumes a more severe type, and that convalescence is much slower, when patients are exposed to such sewage-polluted atmosphere.

"VII. Stony Brook, above the entrance of the sewer, is jealously guarded by private corporations who use its water for manufacturing purposes; and the slight pollution of a few other small streams cannot do much harm.

"No drinking-water is derived from any source within the limits of the city, except from Jamaica Pond and the neighboring Ward's Pond, which serves as a filtering basin to the former. Both are protected from contamination by direct drainage;* but, on the south shore of Jamaica Pond is a large stable belonging to an ice company, where a large number of horses are kept. Some of their refuse probably finds its way into the pond, although a certain portion would first be filtered through the soil.

"(*b.*) The atmosphere in the vicinity of the Charles River is polluted seriously, both by emanations from the banks of the river

* Prof. W. R. Nichols appends to his memoranda of analysis of this water, the following: "I did not examine the edges of the pond all the way round, but I think the direct drainage must be small. In samples 1 and 2 we thought we obtained a trifle more nitrogen as nitrates and nitrites than is *naturally* to be expected in water, but the amount was *very* trifling." Prof. Nichols visited Jamaica Pond and took his samples, Nov. 22, 1875.

at low tide and by foul gases arising from the river itself. People are actually sometimes driven out of their own houses by the stench in hot weather, and during the past summer it has been necessary to close windows. The Roxbury Canal is another instance of a similar, but graver, nuisance.

"(c.) Small streams in cities are almost inevitably converted into sewers. There are certain evils, however, which we have seen exemplified in Boston. If such sewers are built tight, the neighboring soil is drained less rapidly than before, in case of heavy rain. If they are built with loosely-jointed stone, as is often done, the sewage passes freely into the soil (as in the case of the Stony Brook sewer) and we have all the evils of loose-walled cesspools, but on a larger scale. If they are built of moderate size, they are gorged in case of heavy rain, the subsoil is saturated, and the cellars are flooded. If they are built large enough to carry off all the flood-water, they serve as immense reservoirs for the collection of sewer-gases during dry weather. If they are kept open, they are filthy, and cause bad odors; but it has not been, in Boston, possible to trace disease directly to this source. In one case, where a stream of small size was first used as an open sewer, it has since been covered in with loose walls, but is too small to carry off the storm-water. Here the cellars are flooded occasionally, and the subsoil becomes saturated with filthy water. I have attributed in one case a certain amount of scarlet fever, typhoid fever and diphtheria largely to this cause, especially as the locality is otherwise wholesome, and the people are clean and intelligent.

"VIII. At the South End, chiefly between Dover and Northampton streets, are between six hundred and seven hundred cellars which are at times wet or damp. In the old parts of the city, where land has been made of bad material, the water soaks through the soil as through a sponge, and the cellars of a large part of the tenement-houses are frequently wet. Many cellars, however, are very low, some being only four and a half feet above low-water mark, and these cannot be expected to remain dry.

"IX. All the sewage emptied into the Charles River above Boston helps to render the river a polluted instead of a pure one. Being at a low level, having a large drainage-area, and flowing through or by quite a number of manufacturing towns, it becomes the natural receptacle of much of the refuse-matter from them. How far down such matter is carried without deposition and chemical change sufficient to prevent it from seriously polluting the atmosphere, it is impossible to say; but there can be no doubt that the evil must become a serious one if measures be not taken to prevent it. A similar statement may be made of the Neponset River. Much of the sewage of

Cambridge and Somerville, including the large pork-packing establishments of the Miller's River Basin, discharges now on the flats of the Charles River. It cannot be said how far its poisonous influence extends over the cities adjacent.

"Cochituate Lake is in danger of contamination from Pegan Brook, a small stream flowing through the town of Natick, and receiving from it the house-sewage and the refuse from several factories. Two plans are proposed for diverting this nuisance: one to drain Pegan Brook into Bacon's Brook, a tributary of Charles River, which it enters just above South Natick; and the other to divert the sewage into the Sudbury River near its junction with the Concord, by a sewer passing around the west side of the lake. By either plan, it would be necessary to cut off from the lake about a square mile of its drainage-area.

"The country drained by the Sudbury River is but thinly settled, nor is it likely to be built up rapidly; it contains few soluble rocks or earths, has quick slopes, and there are very few manufactories along the banks of the river; so that the water is quite pure. After heavy rains in the summer and autumn, when the drainage-surfaces are covered with decaying and dead vegetable matter, the water becomes somewhat discolored, and has a slightly bitter taste. It is then unfit for bleaching purposes. The color and taste, however, disappear on storage. The towns of Framingham, Marlborough, Westborough, Ashland, Southborough and Hopkinton, are on or near the Sudbury and its tributaries, and probably drain more or less into these streams. The quality of the water must in time become affected, unless these towns are provided with some proper system of sewerage to carry away all sources of pollution from the water-courses. It is proposed to have several storage-reservoirs for the supply from the Sudbury River.

"Farm Pond is in danger of pollution from its proximity to the growing town of South Framingham.

"The natural waters of the Mystic Valley are very pure and colorless, but the tributaries of the lake have for a long time been used as receptacles for the refuse from a large number of tanneries, wool-scouring establishments, etc., in Woburn and Winchester. These towns have not yet sewerage-systems, but drain into cesspools, ditches, etc. On the tributaries of Mystic Pond are fifty-five factories, of which twenty are leather-works, and they employ about three thousand men. It is estimated that about seven per cent. of the water that flows into the upper Mystic Pond is the drainage from factories.* Fish have been killed in the pond, and cattle have refused to drink the water of the Abajonna River.

* Report of the Cochituate Water-Board, 1874, p. 20.

COCHITUATE LAKE,

and other Sources of Water Supply of Boston, 1875.

"The legislature has given to the city of Boston permission to discharge all this offensive sewage by an intercepting sewer into the lower Mystic Pond, where the tide rises and falls only a few inches. This would make a cesspool on a colossal scale; for experiments made by the State Board of Health during the past summer show that sewage would remain indefinitely in the pond without any discharge.

"A later plan is to discharge the sewage into the Mystic River, as shown on the accompanying map,* at a point two thousand feet below the pond; but this is likely to be the source of nuisance, if carried out, and at no very distant time.

"X. There is no feasible remedy excepting a long intercepting sewer to discharge at some distant point by means of pumping."

Additional facts are given of the condition of one of the tributaries of Mystic Pond in the following notes of an inspection of a portion of the East Branch of the Abajouna River for a distance of two hundred and fifty rods in a straight line, or about a mile and a half by the course of the brook.

Alongside Washington Street where the brook flows, all weeds, etc., in its bed were coated with an ash-colored substance, of slimy feel, which completely concealed the green of the plants. On close inspection this seemed largely composed of minute shreds. The planks in the apron of an old dam twenty-five or thirty rods above showed the same coating. This same appearance was found all the way up to the glue factory (also in the canal which diverts a portion of the water). No fish or aquatic insects were seen between the two points mentioned. The water is at first slightly turbid, and grows more so till the factory is reached. It becomes of the color and opacity of very foul sink-wash, within a quarter of a mile of the factory.

The works stand on rising ground some five hundred feet east of the stream, and quite near the Stoneham Branch Railroad. West and south-west, and between them and the stream, are five or six acres of boggy meadow, on which there was everywhere standing the disgusting yellowish-white drainage of the works, several inches deep. From a distance of two hundred and fifty feet could be seen the whitish stain of two streams of drainage running down from the factory

* See page 244.

into the meadow. In the north quarter of this meadow were a number of settling-grounds for the drainage, bordered by old boards, with a little rampart of earth about six inches high thrown up against them, within which a space perhaps sixty feet square was flooded with sewage. From arranged outlets, streams of this stuff run directly into the brook. Only one of these areas was in use, several others being bare, not dry. One rod above the grounds of these works the brook was clear, and the aquatic vegetation bright and healthy. A little farther up I saw aquatic insects in numbers.

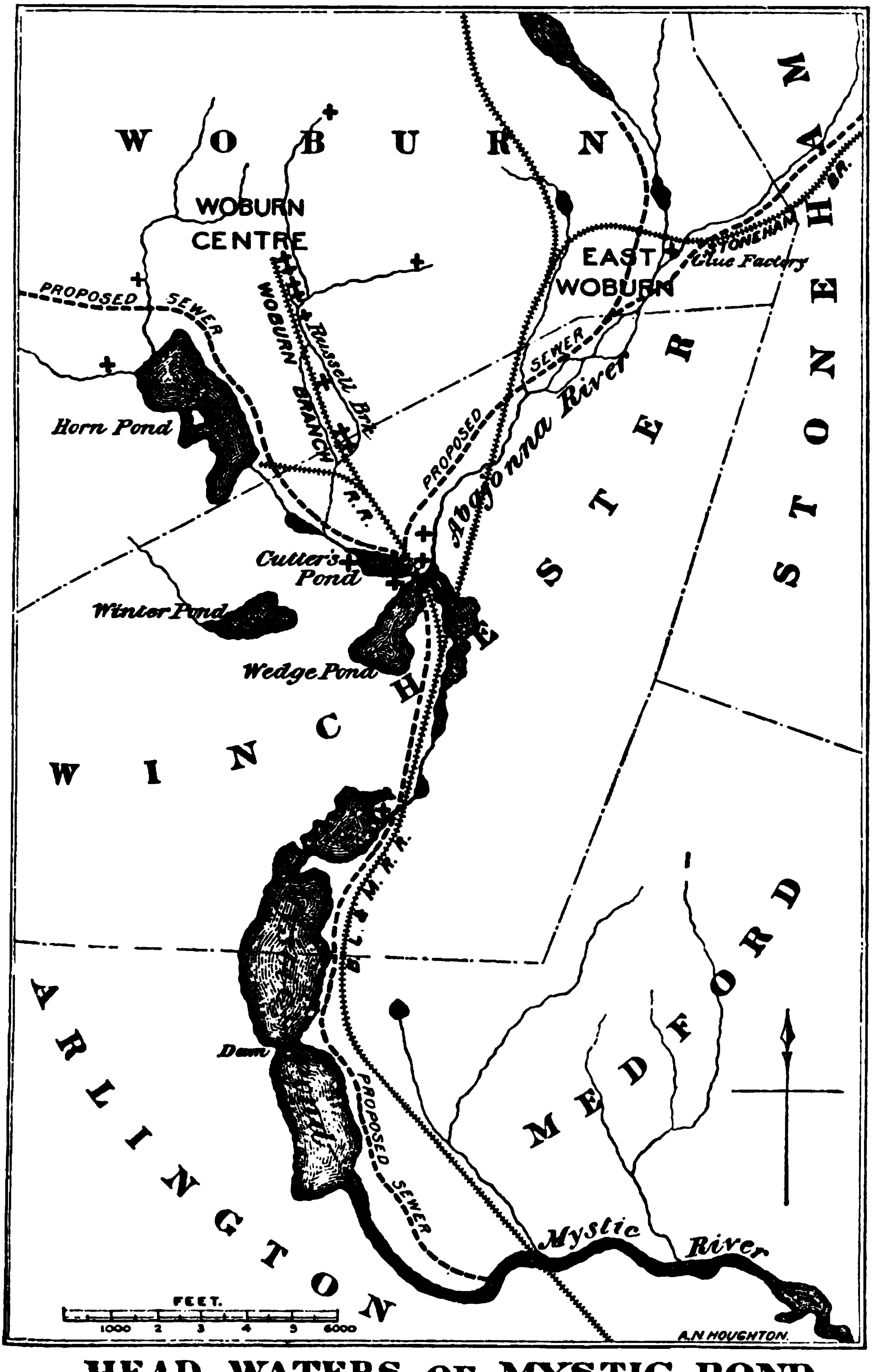
In some parts of the stream fish are sometimes killed in great quantities. Such was the case early last September, on the twelfth day of which month the little mill-pond (where the canal approaches the main brook) was full of dead fish, some floating, some sunken. Eels two feet long, and fry an inch long, alike found the water too strong for them.

The industry which thus poisons this valuable stream, is the washing of hair scraped from hides in the process of currying, and loaded with putrescent animal matter and lime; also the manufacture of glue from the refuse of currying-shops and slaughter-houses. It is a profitable and growing business. One-sixth of a mile lower, the stream is entered by the drain from a large tanning and currying shop in Stoneham Centre, into which also enters much other sewage from factories and dwellings in the same town.

Statistics of Leather Manufactories of Woburn and Winchester for 1875.

Business having been duller than in 1874, the figures will be found lower than those for that year given in the "Report of the Mystic Water-Board in relation to Sewage," or those for the same year given in the report of the medical commission on the sanitary qualities of the Mystic and certain other waters.

Number of hides finished per week,	5,200
of hides finished during year,	270,400
of barrels of lime used during year,	108,160
of pounds of soda used during year,	42,204
of pounds of sulphur used during year,	42,204
of gallons of water used during year,	108,160,000



HEAD WATERS OF MYSTIC POND.

+ Denote Sources of Pollution, mostly Leather Works.

To each hundred hides there are used 40 barrels of lime, 16 pounds of soda, 16 pounds of sulphur, and 40,000 gallons of water. The most of this filth drains directly or indirectly into the waters of the Mystic basin.

Specimens for chemical analysis were taken from Lower Mystic Pond, in consideration of a proposition to empty the sewage of Woburn and Winchester into it. It was known that there was very little current out of this pond, and that the tide which enters twice a day from Mystic River, so far from scouring it, tends only to bring in more filth. Moreover, the shape of the bed of this pond forbids its ever changing its water fast enough to prevent decomposition of filth that once enters. The bar crossing it, and separating it from the upper pond, is sufficiently broken down to allow of some wash over from one to the other; for when the depth of water on this bar is compared with that of the basins, the interchange between them hardly deserves any other name. In November, 1875, some floats were placed in the northern part of this pond, and their movements watched during fourteen days. For the most part they swung about the spot where they were placed, without crossing the bar or approaching either shore. On four occasions, when the wind was fresh, they reached the shore, twice to the eastward, once to the westward of the spot where they were set adrift and above the bar; once only far to the south-eastward of the bar. Not one of them reached the outlet.

The specimens referred to were taken at different depths, varying from twelve to forty feet, by an apparatus which prevented the entrance of any water until the desired depth was reached.

Comparisons of analyses made, from fifteen years ago to the present time, by chemists as well known as Silliman, Horsford, Hayes, Merrick and Nichols, show the water of this Lower Mystic Pond to have been very foul during the whole of that period, and to have been growing gradually worse, although there are very few dwellings on the large estates which border them. The introduction of the vile

sewage of the tanneries, etc., elsewhere described, could result only in making an enormous cesspool of this pond.*

Prof. Nichols remarks with regard to the analyses given in the following table:—

"Nos. 1 and 2 contained enough sulphuretted hydrogen, when opened, to color lead-paper held over the mouths of the jars. On boiling the water the sulphuretted hydrogen was driven off and estimated. On subsequent treatment with acid, only a trace of sulphuretted hydrogen was obtained.

"There is no significance in determining the 'loss on ignition,' as the mineral matter is decomposed to such an extent in such waters."

Examination of Water from Mystic Lower Pond.†

[Results expressed in Parts per 100,000.]

Number.	Date.	LOCALITY.	Ammonia.	"Albuminoid Ammonia."	Total Solid Residue at 212 deg. Fahr.	Oxygen required to oxidize organic matter.	Sulphuretted hydrogen.
1,	1875,	Mystic Lower Pond,	0.3040	0.0480	1,102	2.570	0.46
2,			0.5040	0.0688	1,465	3.197	1.86
3,			0.6400	0.0672	1,733	5.736	0.07

† The waters of the pond are shown by this analysis to be already so filthy, that any addition of sewage could be looked upon only as a very grave evil.

Chicopee.

"Water has been introduced by an aqueduct company from springs which appear through the sand on the high plateau above the Connecticut River. This water is almost universally used in the village, and is pure at the start, where it comes up through sand. By the use of logs, lead-pipe, etc., as conduits, and from the foulness of reservoirs, the water, when drawn at the houses, is often rendered impure, especially when it is so low as to be kept shut off from nine o'clock, A. M., till five the next morning, as is the case often in summer. A small stream reaches the faucets in the cellars, sometimes when none can be had above-stairs. The inadequate supply of water is getting to be a great evil here. The aqueduct company

* The plan has now been abandoned in favor of one to discharge the sewage at a point in Mystic River, where it can hardly fail to be a source of nuisance in time.

have kept continually adding to their list more families to be supplied with water, as the village became more built up,—while there has been no considerable addition to the source of supply. The effect, of course, has been to cut nearly everybody short of the necessary quantity of pure or freshly-drawn water, in summer, when cool water is most needed, for a part of the twenty-four hours. A disease has been prevalent here, which the people call the 'water diarrhœa,' believed to be caused by the low-water impurities.

"This condition of the water must have a more or less injurious effect on the health of the people. In many places we cannot drive wells. Where they can be dug, the water from them is often 'swampy,' and bad tasting.

"The town has, at considerable expense, prepared a general system of sewerage for the village, but the plan is as yet only partially carried out. It is satisfactory so far as it goes. We have a few large sewers, and some smaller ones, but the one or two most needed —those which would drain the most crowded streets of the town— are not yet built.

"Where the sewers are not built, the sewage from most of the corporation buildings runs into the canal, which feeds the factories with water-power, and thence into the Chicopee River. Almost all of the sewage from the village where sewers are not built (probably more than one-third of it) runs on to the surface. Perhaps one-fourth goes into sink-holes. We have but few cesspools. That which runs on the surface is often offensive. Very many wells are exposed to contamination from privy-vaults, and are seldom used.

"We have formerly had typhoid fever in Depot Street from surface-sewage, I have not a doubt; also in West Street, from the open mouth of a large sewer; also cerebro-spinal meningitis, two years ago, from a pool of foul sewage which collected in Park and Spruce streets. This was finally drained off into a small brook or water-course, open for thirty or forty rods. This brook is now, however, being made into a covered sewer. There is no serious offence here after the sewage has once reached the water-courses.

"I have been satisfied for years that damp and wet cellars have caused fever and other forms of disease. We have more typhoid fever on Front Street than anywhere else among the same number of people. The street faces the canal, and is heavily shaded with elms. Many of the cellars are damp."

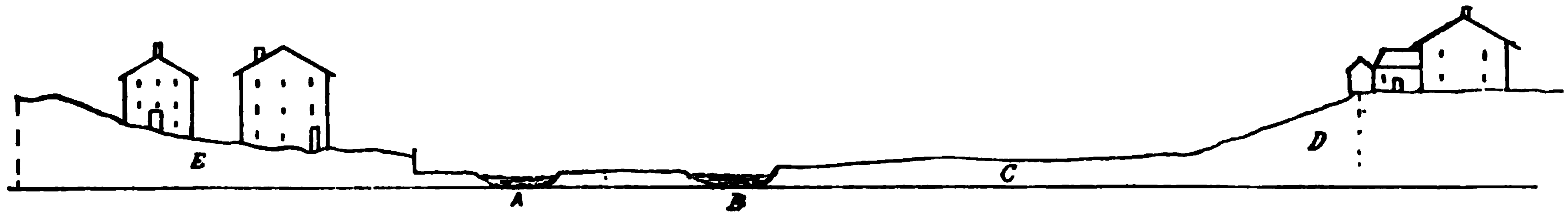
Fall River.

"A considerable portion of this city in the low-lying districts suffers from a damp soil, wet cellars, and consequently, from a considerable measure of disease, owing to the fact that a mill-dam has

raised very decidedly the level of the adjoining water, thus obstructing the natural drainage of the soil. A competent engineer, however, has examined the question thoroughly, and advises that the dam be removed. The matter, therefore, does not require further comment at present."

Haverhill.

"*Little River* is a large brook, rather than a river, flowing through the western part of the more thickly-settled portion of Haverhill. It is the natural outlet for the surface-drainage of this part, below the level of which its valley, in width about three hundred feet, sinks about twenty feet (as is shown in the diagram of a cross-section of this valley). Its length in a straight line from Hale's Pond to the Merrimac River at Washington Square, as is shown by the second map, is about one-third of a mile. The tide flows somewhat less than half-way up it. At high tide, it is about thirty feet wide and three feet deep. Sometimes it is scarcely a foot deep in mid-channel. Its left bank, between the upper bridge and Washington Square, is very low and flat for about one hundred feet from the stream, and showed in two places at least an extra channel (dry). This shore was slimy, overgrown with tall, rank weeds, and is evidently a regular garbage-ground for the reception of 'dry dirt' and offal, which were soaked in sewage. Here and there lay dead cats and fowls. It then rises sharply (say at an angle of forty degrees) to a level of some twenty-five feet higher. This broken bank is crowned with the privies, hen-houses, pigpens, etc., of the poorest class of dwellings. Three public sewers and many private drains open on it. The right bank has much less low ground, and the dwellings along it are of a somewhat better order. For two hundred and fifty or three hundred feet here the stream is bordered by a wall nine feet high, made of large stones, without mortar; three or more privies overhang it; three public drains, and all the house-drains, empty on this bank. Above the bridge the population is more sparse, and there is the same state of things in a less concentrated form. At the gas-works, near the dam (see map), the stream makes a pool, and just above is again rapid. At the dam is a woolen mill. In times of drought, when this mill is idle,—as on Sunday,—the bed of the stream is *dry* down to 'tide-water.' At Washington Square the current is sluggish. This 'square' is the very centre of the business part of Haverhill, four principal streets converging there (see diagram), and is about twelve hundred feet from the station of the Boston & Maine Railroad. It bridges Little River, the distance from the water to the key-stone of the arch being twenty feet. Below Washington Square the stream and its banks are an offence to sight and smell.



Cross section at head of tide water of Little River.

A & B. Channels of River 30 feet wide and 3 feet deep at high tide.
C flat Eastern shore 100 feet wide
D East bank 20 feet high
E West bank " "

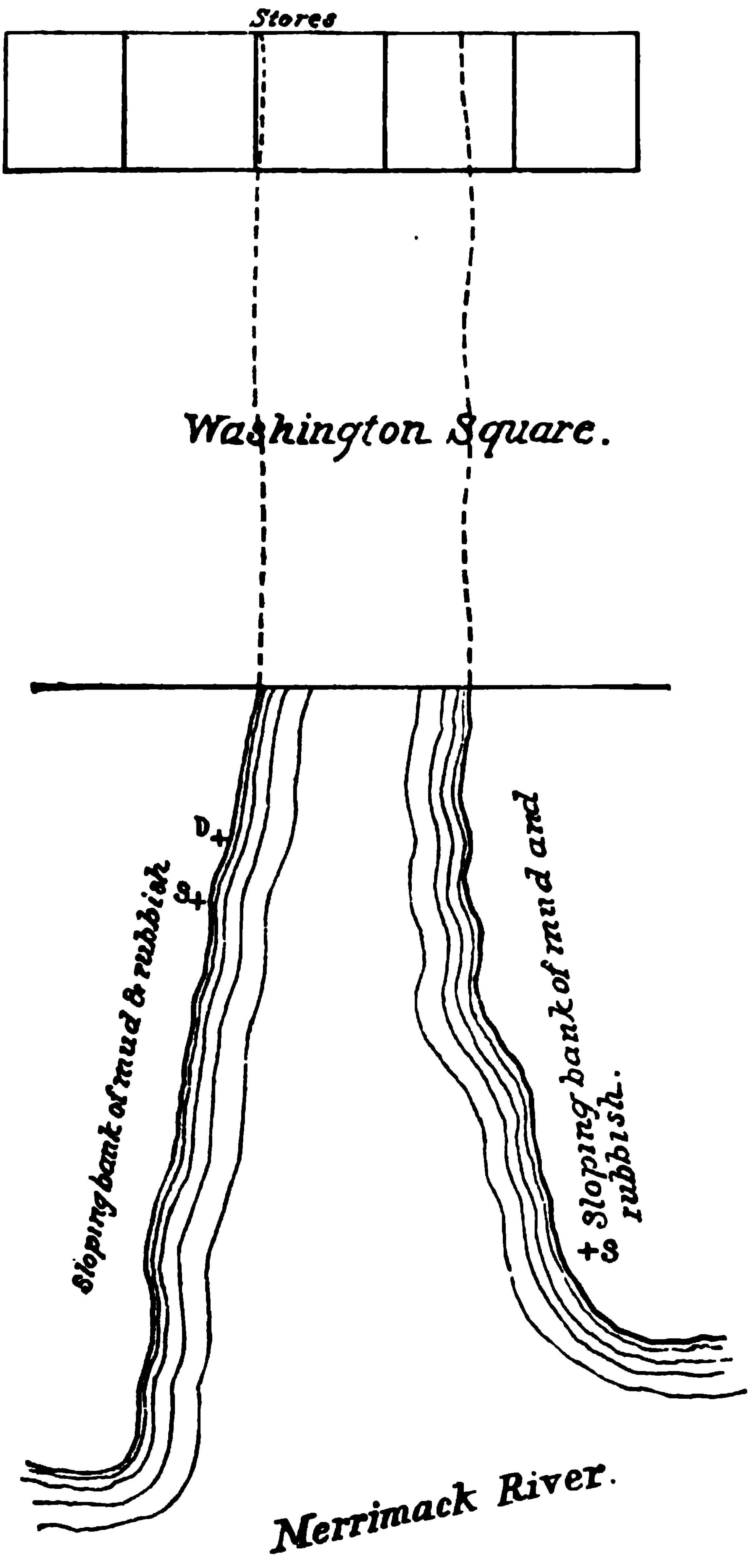


Diagram of mouth of Little River

Dotted lines show the Stream bridged over by Washington Sq. and stores, about 140 feet. Banks 125 & 150 ft. respectively from Square to Merrimack River. SS, small sewer. D, large drain.

For particulars, see diagram. Extended comment is unnecessary. The whole valley of this brook is foul and unwholesome. On inquiry from physicians, I was told that sickness is frequent and severe in the dwellings bordering it."

Further particulars in regard to Haverhill are given in the following extracts from the reply to our circular:—

"We have sewers, but can hardly say that we have any sewerage-system. Sewers have been constructed from time to time, although without much reference to a system, and most of our principal streets now have them, discharging their contents into the Merrimac and Little rivers. Many of the sewers enter the river through a line of wharves above the high-water mark. The odor arising from this source is often offensive, but no marked effect upon the health of the community has been noticed.

"Little River, a small stream entering the Merrimac at Washington Square, receives the filth from the gas-works, and also from several large manufactories. It also receives the sewage coming from the western slope of the city. When the stream is swollen by freshets, this sewage is easily carried into the Merrimac; but in summer, when the water is low, the filthy mass is spread over the river-bed, and the odors arising therefrom are extremely offensive. Much of it is deposited on the flat surface at the mouth of the river, and at low water it presents a most disgusting sight to the multitude of people constantly crossing the bridge. The odor frequently arising from this reeking filth is very offensive. We hope soon to succeed in remedying this evil by extending the arch of the bridge to the line of the Merrimac. This is a striking instance of the bad effects arising from the use of small streams for sewers. The water of Little River is not used for drinking purposes.

"Our city is located upon a heavy clay deposit, and nearly all our cellars are more or less damp. This evil is largely obviated by sewers and cemented cellars. In the newer portions of the city the evil is more apparent, and sickness can often be traced to this cause."

Lynn.

"There is a stratum of dense clay, impervious, of course, to water, underlying the whole of the city of Lynn, with the exception of the rocky hills which are situated in the rear, and which are only to a limited extent inhabited.

"The depth of this stratum beneath the surface varies. In some places it rises to the surface, or near it; in others, dips down, forming valleys and basins of varying shape and extent. It is, in reality,

an irregularly undulating stratum. The basins act as reservoirs for the storage of water, sometimes being far underground, sometimes coming near the surfaces and forming marshes or bogs, and sometimes showing themselves as open ponds. The valleys are the channels for the discharge of overflow, giving us either open or subterranean water-courses, or brooks.

"The stratum of clay is variously covered with fine sand, fine and coarse gravel, mixed with bowlders and loam. The hills in the rear have a basis of solid rock, chiefly porphyry, which crops out in many places, but is for the most part covered with loose gravel and loam.

"At Harbor Street, and in the vicinity, the clay comes up to the surface, or to the loam. There is a brick-yard there. From this point easterly, across Pleasant, Market and Washington streets, to the rising ground, the clay is nowhere more than four feet below the surface. From Washington and Munroe streets north-westerly to the junction of Essex and Washington streets, the depth averages about four feet. The region thus indicated constitutes a sort of valley through which a brook once ran, which was cut off, or diverted, by the Market Street sewer.

"Beyond Essex Street, in the region of Hanover, Johnson, Leighton streets, etc., the clay is deeper—eight to twelve feet below the surface. Here was a basin, formerly a swamp, drained by the aforementioned brook, but now drained more perfectly by the sewers, and built up with residences. Young people, less than thirty years of age, have told me that, when children, they used to go to this place to skate, as in winter it was often a pond; now there are very few vacant lots there.

"At the corner of Summer and Market streets the clay is not more than four feet below the surface. A few rods west it falls down suddenly to nine or ten feet.

"In the region of Silsbee, Green, Nahant, Ocean and Lewis streets, and towards Wood End from this section, the clay is much deeper. In the valley of Stacey's Brook (east side) and its branches, it is somewhere about eight or ten feet deep. At Bog Meadow (the swamp back of the soap factories) it is deeper, giving us another basin. The meadow is drained by Stacey's Brook. At Glenmere, around said meadow, it is also quite deep, and beyond, dips down probably under Flax Pond and its tributaries. On Holyoke Street (west side) there are three brick-yards, showing that the clay is at the surface. This is in the region of Stony Brook and branches. (I think there is a branch from the direction of Holyoke Street.) At Cottage Street there is another brick-yard. The stratum runs down as you go from this point towards the common (south-east),

"During the past winter and spring, the supply of water was, for a portion of the time, short, and of very poor quality. Great numbers of the service-pipes, also, were frozen. Owing to these circumstances, people resorted, in many instances, to their old sources of supply,—the wells, which were also low. There was an unusual amount of typhoid fever in the city during this period. A large number of cases, and eight deaths, occurred from January to June, a portion of the year in which, ordinarily, the disease is but rarely observed.

"The harbor-bottom is composed of mud, and is almost entirely bare at low water. The tidal-flow reaches the mouths of the sewers, except in one instance, that of the Shepherd Street sewer, which discharges on the flats. The sewage is not properly carried off into deep water. Its solid portions accumulate near the mouths of the sewers, and are very offensive. When the wind is from that quarter, the odor of the sewage-mud is plainly perceptible at a distance, in the higher portions of the city. The region which borders the harbor and flats is the most unhealthy part of the city, a fact due partly, perhaps, to the sewage, and partly to other causes. As the sewers have all been constructed within a few years, the evil from this improper disposal of the sewage is one only just beginning to be felt. It must constantly increase, and, unless remedied, become a great source of discomfort and disease.

"As the number of sewers is so small, and only 360 private drains in all connect with them, the greater part of the sewage of the city must be disposed of in some other way. It is, perhaps, fair to state that one-third part of this amount runs directly on to the surface, or into uncovered sink-holes, or under privies without vaults; and that the remainder runs into cesspools, including, under this term, the casks or hogsheads set into the ground, and the old-fashioned vaults. The proportion which runs under privies, or into vaults under privies in the house, or dwellings connected with the house, is very small. Of that which runs into cesspools, about three-fourths, I should judge, runs into casks set into the ground, and covered up; the remainder into regularly constructed cesspools.

"In many instances, these receptacles of sewage are very near the dwelling, and wells are directly contaminated from them. They also sometimes leak into cellars, and their emanations contaminate the air of the house. The foul water is allowed, for the most part, to soak away into the ground. In this way, the whole soil about the dwellings has become filthy, so that there is no security for the purity of well-water within the thickly-settled portion of the city.

"About one-fourth part of the ground-drainage of the whole city,

including the sewage of families and of manufactories, the washings of streets, and of the soil about dwellings, goes directly into ponds and brooks. It is, of course, understood that this amount includes a portion of that which was said to have been discharged on the surface.

"There was formerly, for many years, a large dye factory at the upper end of Flax Pond, which received its water, for power and other purposes, from Sluice Pond, and discharged its abundant sewage into Flax Pond. There are now, although the factory is no longer in existence, large quantities of offensive matter deposited from this sewage, at the upper border of Flax Pond. One wool-pulling mill and one morocco factory drain into the pond at the upper end. One glue factory drains into Stony Brook. Two morocco factories drain into the lower part of Strawberry Brook. A large number of morocco factories drain directly into the docks. All the drainage of Wyoma Village, and a part of Glenmere,—with a population of some 1,500 or more,—drain into Flax Pond and its tributaries. Stony, Stacey's, and Strawberry brooks receive the surface-drainage, and a portion of the sewage of dwellings, from their respective water-sheds. In the rear of Essex Street, between Fayette and Chatham, on the north side, there is a large hollow, and in it a pond, with no outlet, called 'Silver Lake,' a decided misnomer. It has steep banks, and on one side of it is a dense and filthy Irish settlement, which, having no cesspools or vaults to its privies, or sewerage, drains everything directly into the pond, which has become, by this means, a reeking mass of foulness. The neighborhood is very unhealthy, abounding in dysentery, typhoid fever, consumption, etc.

"This pond is a short distance in the rear of the Ingalls School, which has a daily average attendance of over 400 pupils.

"There is a probability that Flax Pond and its tributaries may be taken by the city as an additional source of water-supply, but I know of no instance here where the water from pond or brook, contaminated by sewage, is now used for drinking or cooking. Many polluted wells are still used in preference to the water supplied by the city."

The following table shows the results of the examination of the waters referred to by the medical correspondent in Lynn :—

Examination of Water from Lynn.

[Results expressed in Parts per 100,000.]

Number.	Date.	Locality.		Ammonia.	"Albuminoid Ammonia."	Solid Residue. Inorganic.	Solid Residue. Organic and Volatile.	Solid Residue. Total at 212 deg. Fahr.	Chlorine.
1	Oct. 21, 1875,	Well, Whiting Street,		0.2267	0.0213	33.30	8.00	41.30	4.44*
3	" 21, 1875,	Well, Western Avenue,		0.0173	0.0093	26.80	7.90	34.70	5.28†
4	" 21, 1875,	Well, Friend Street,		0.0096	0.0051	20.60	3.40	24.00	2 84†
2	" 21, 1875,	Strawberry Brook,*a* [1]		0.0061	0.0133	3.00	1.48	4.48	0.64†
5	" 21, 1875,	Flax Pond, near outlet,		0.0160	0.0136	3.12	1.08	4.20	0.56†
	Dec. –, 1874,	Flax Pond, gate-house,*b*		0 0047	0.0122	2.76	0.74	3.50	0.42
	" –, 1874,	Flax Pond, near entrance of Sluice Pond,*b*		0.0053	0.0109	2.00	1.00	3.00	0.42
	" –, 1874,	Sluice Pond,*b*		0.0052	0.0117	2.12	1.04	3.16	0 44
6	Oct. 21, 1875,	Silver Lake,[2]		0 0147	0.0790	6.36	6.36	12.72	1.60†
7	Nov. 11, 1875,	Stream joining Sluice and Flax ponds,*c* [3]	Unfiltered,	0 0012	0.0240	8.32	3.60	11.92	2.36*
			Filtered,	0.0012	0.0144	–	–	–	–
	" 20, 1875,	Twenty rods below morocco factory,[4]	Unfiltered,	0.0130	0.0160	4.56	2.24	6.80	–
			Filtered,	0.0130	0.0140	–	–	–	–
8	" 11, 1875,	Same stream as No. 7, but near Flax Pond,[5]		0.0087	0.0160	2.20	2.40	4.60	0.72†
	" 20, 1875,			0.0116	0.0220	4.92	3.72	8.64	–

9	Nov. 11, 1875,	Flax Pond,d	0.0061	0.0173	2.60	1.40	4.00	0.68†
10	" 11, 1875,	Strawberry Brook, below Bridge Street bridge,[6] — Unfiltered,	0.0800	0.1000	9.12	4.60	13.72	2.00†
		Strawberry Brook, below Bridge Street bridge,[6] — Filtered,	0.0800	0.0560	–	–	–	–
11	" 16, 1875,	Birch Pond,[7]	0.0400	0.0460	3.40	5.00	8.40	0 50†
12	" 16, 1875,	Birch Pond, gate-house,[8]	0.0440	0.0512	3.68	4.24	7.92	0.46†
13	" 17, 1875,	Stacey's Brook,[9]	0.0188	0.0260	5.40	3.44	8.84	1.20†
14	" 17, 1875,	Stacey's Brook,[10]	0.0440	0 0280	7 20	3.52	10.72	1.65†

a Strawberry Brook is the outlet of Flax Pond.
b Analyses made for the city of Chelsea.
c Taken some five hundred feet below the goat-skin factory.
d Taken about half-way from inlet to gate-house.

1 Taken below Park Street bridge.
2 Full of green vegetable matter and low animal life.
3 Quite black, owing to suspended matter which settles, leaving the water nearly colorless.
4 Only slightly colored. No black sediment.
5 Somewhat colored.
6 Quite strongly colored.
7 Deep yellowish-brown color. Taken near upper end, near farm-houses.
8 Deep yellowish-brown color.
9 Somewhat colored. Taken above bridge on Brookline Street.
10 Somewhat colored. Taken as the brook issues from Bog Meadow.

* Nitrates enough to answer to sulphate-of-iron test in unconcentrated water.
† Trace of nitrates when the water is considerably concentrated.

No. 1 is from a well which has not been used since the occurrence of typhoid fever, attributed to drinking the water from it during the last spring. It is evidently contaminated by drainage.

No. 3 is from a well situated at the bottom of a valley, with a dwelling on one side and out-houses on the other. Five cases of typhoid fever have recently occurred in the dwelling. The water is evidently unfit for use.

No. 4 is from a suspected well.

By comparing Nos. 5 and 9 with the analyses made in 1874, it will be seen that the purity of the water in Flax Pond has decidedly deteriorated during the past year. If a supply of water should be taken from this source for the city of Lynn, it is evident that the pond must be better protected from pollution than it is at the present time.

Prof. Nichols remarks, with regard to some of the specimens, as follows:—

"No. 7 was taken below a goat-skin factory, and is, no doubt, much contaminated. The character of the water must vary very much at different times, as is evident from the two samples. The first, taken November 11, was quite black, owing to suspended matter which settled slowly. This black matter seemed to be some sort of dyestuff, and the water was further remarkable for the small amount of ammonia. I should infer that some 'emptying' must have been going on at the time. The two samples could hardly have been suspected as coming from the same place. In the event of Flax Pond being used as a source of water-supply, this should be looked to, and the factory stopped. I do not think chemical examination alone can show that the pond itself is at present contaminated.

"Strawberry Brook (No. 10) and Silver Lake (No. 6) speak for themselves. The latter water was full of green matter, which, under the microscope, was seen to be made up of minute animals of low order, and vegetable matter in the state of decay (when received by me).

"Birch Pond water is strongly colored and highly charged with organic matter, which I think is mainly of vegetable origin. That some animal matter is derived from the overflowed meadow, and from the farm-house which is near the upper end, I have little doubt; but the amount cannot be great. I do not think that it can be positively said that the water is contaminated by sewage. Stacey's Brook speaks for itself."

"The emanations from the docks and flats have already been referred to. The stench in the neighborhood of these places is almost or quite unendurable, to one who has not become accustomed to it. Silver Lake is a constant source of foul odors during the summer season. The brooks are briskly running streams for quite a portion of the year, and do not become offensive to any great extent. The accompanying map gives the position of the sewer-outlets in the docks, and shows what must be the nuisance therefrom.

"Wet and damp cellars are very numerous, especially in the flat and undrained portions of the city; and they are sometimes found at the foot of our hills or high lands. Cases of typhoid fever, acute rheumatism, pneumonia, dysentery, diphtheria, croup, and chronic wasting diseases are more frequently observed in such houses than where the cellars and subsoil are dry.

"I would make the following suggestions:—

"*First.* That a definite plan be adopted for completing the system of sewers.

"*Second.* That the sewage be discharged into Saugus River, where it may be washed off into deep water; or carried out farther into the harbor, so that its solid portions may not be exposed during low water.

"*Third.* That drainage into the sewers, in all the densely populated parts of the city, be made compulsory.

"*Fourth.* That while waiting for the completion of the system of sewers, greater vigilance be used by the health authorities in looking after the condition of privies, and the disposal of sewage which runs on the surface. Said authorities are now, as they have been for many years, notoriously lax and inefficient."

Salem.

"There have been four sources of complaint in this city*:—

"1. The defective sewer crossing the lots between Norman and Creek streets.

"2. The 'mill pond' in South Salem.

"3. The outlets of the sewers on the various water-fronts of the city.

"4. The use of North River, and streams emptying into it, as common sewers.

* Salem has already been referred to in connection with the subject of running streams used as sewers. A report of a special investigation, including map, by C. D. Ward, C. E., is now given, showing the many sources of nuisance to the inhabitants. The filth of Peabody, which is reported as not being a serious source of offence to that town, contaminates the air of Salem to a great degree.

"The first trouble is now done away with, a new sewer having been built in place of the old and defective one.

"*Second.* The mill pond covers in all some fifty or sixty acres. At its lower end there was formerly a tide-mill, and of course a narrow opening, with gates where the tide flowed in. This narrow opening remains, although the gates are no longer used. The Eastern Railroad crosses the pond twice. At the lower or northern crossing there is a bridge, with an opening fifteen feet wide; and at the upper or southern crossing a circular wooden culvert, five feet in diameter. Still farther south, Ocean Avenue crosses the eastern arm of the pond, leaving a space under the road about seven feet wide. Of course, these narrow openings interfere very much with the free ebb and flow of the tides.

"That part of the pond above Ocean Avenue contains four acres and a half, and receives the drainage from an area of about one hundred acres. Its bottom is covered with a layer of mud and sewage from three to six feet deep, a large portion of which is exposed for many hours each day, giving forth most offensive and dangerous exhalations. It is this part of the mill-pond alone of which serious complaint is now made; but the same condition may be expected in the lower portion also, in time, if nothing is done to prevent it.

"*Third.* There are in the city eight miles of public sewers, with twenty-four mouths or outlets. The majority of them empty at a level but little below high-water mark, where, the water not being very deep, the flats are soon left bare by the falling tide, retaining for a long time the filth deposited on them. Some of the sewers empty into coves and docks and ponds, where there is no current to wash away their deposits, so that a large portion of the sewage must remain where it is discharged, becoming the source of offence.

"*Fourth.* The nuisance most complained of is the use of the North River, and streams emptying into it, as common sewers. While the amount of sewage was small, and the volume of the water in the river large in comparison, there was no complaint of pollution; but now that the former has largely increased with the growth of business, and at the same time the river, instead of increasing, has been greatly diminished in capacity by deposits on its sides and bottom, there are loud complaints made by those living at a distance, as well as by those near to it, of the sickening stenches which compel people at times to close their windows.

"Commencing the examination of the North River at its mouth, the current is there found running swiftly as the tide rushes in or out. Proceeding up the river, the channel soon narrows, so that at low tide the flats on each side are very wide and gradually rising, as refuse matter is deposited on them. The first bridge over the stream

is about one mile from its mouth. There the river still farther contracts its channel, and becomes more crooked, with less depth of water. After passing a railroad bridge and one or two other small bridges in about three-quarters of a mile, we come to "Frye's Mill Dam," above which is a tide-mill with its dam and gates. The pond thus formed was formerly deep and held a large quantity of water, but it is now very much filled up with filth. It is nearly half a mile long, and, when full, averages one hundred and fifty feet wide; but, when empty, the channel is only from fifteen to twenty feet wide; leaving exposed a large area of filthy flats. The abominable odors caused in this way are the cause of the greatest complaint. From the head of this pond to the point where the next one formerly was in Peabody, about one-quarter of a mile, the stream is crooked and from eight to twenty feet wide, with banks but two or three feet above the water. Here the spring tides rise but one foot. In Peabody there was formerly a mill-pond, but it became foul and filthy to such a degree that it was filled up, and a channel was made for the stream between walls sixteen feet apart. Above this point the stream divides into two, Procter's and Goldthwaite's Brooks, which have more descent and less pollution.

"In Salem, eight sewers, with an aggregate length of 11,800 feet, empty into the North River. In Peabody, fifty houses are said to drain into it, beside the water-closets from twenty-eight tanneries, etc., employing eight hundred hands.

"There are three glue factories, one bleachery, one print-works, and fourteen morocco shops capable of tanning and finishing 2,736,000 sheepskins a year. The greatest source of pollution must be from the sixty-two tanneries, having the capacity of tanning 1,235,000 hides a year.

"These hides are twice soaked in salt or fresh water, in vats called 'soaking holes,' and then the fluid is allowed to run into the stream. This effluent is so foul that two samples were sent for analysis; one from a 'soaking hole,' where 150 hides had been soaked ten days for the first time; the other from one in which 175 hides had received their second soaking, lasting five days.

"It is estimated that of sample No. I. 8,646,827 U. S. gallons would pass into the river in a year, and of sample No. II. 9,340,665 gallons, excluding refuse from sheepskin tanneries.

"Twelve thousand bushels of hen-manure are used a year in the tanneries, and are allowed to pass into the river after having remained in the 'drenching vats' for some months, and become very strong.

"The area drained into the North River is fourteen square miles of comparatively low land.

"The population of this district was, in 1850, 12,835, and in 1870, 16,630.

The following table shows the composition of the waters referred to. The amount of pollution of the North River is seen to be enormous :—

Examination of Waters from Salem.

[Results expressed in Parts per 100,000.]

Number.	Date.	Locality.	Ammonia.	"Albuminoid Ammonia."	Solid Residue, Unfiltered. Inorganic.	Solid Residue, Unfiltered. Organic and Volatile.	Solid Residue, Unfiltered. Total at 212° Fahrenheit.	Chlorine.
1*	Aug. –, 1875,	North River, Salem,†	0.552	0.207	204.32	41.20	245.52	108.0
2	" –, 1875,	Salem, Tank No. 1,†	41.000	0.362	273.40	106.00	379.40	98.0
3	" –, 1875,	Salem, Tank No. 2, ...	41.600	0.304	425.60	147.00	572.60	179.2

* Filtered gave inorganic, 204.52; organic and volatile, 40.40; total at 212° Fahrenheit, 244.92; but did not filter very clear.
† Very foul and stinking.

South Braintree.

More than a year ago, a petition was sent to the State Board of Health from fifty-six residents of the town of South Braintree, representing that disease had been caused by certain manufacturers lowering the waters of Little Pond in said town, so as to lay bare at several different times in each year, generally in summer, several acres of the bed of the pond, from which there arose exhalations injurious to health. The case was not one in regard to which the Board had any power; but they gave their opinion that the statements of the complainants were to some extent well grounded. The facts of the case are as follows :—

"As is indicated by the map, the town of South Braintree, containing about 2,000 inhabitants, is built along the southerly and easterly borders of a pond. The land is generally level in its vicinity, with a gentle slope towards the pond. The superficial soil is soft, and underlying it is a clay stratum of varying width, situated from one foot to several feet below the surface. Near the southeastern end of the pond, the average depth below the surface is one and a half feet. This is the portion near which nearly all the disease had its origin. The pond covers an area of about fifty acres; it is fed by the descent of the land and by one small stream only, which runs into it from the north. Here the land is swampy, covering a large number of acres. At low water, there are at least two small islands visible at the lower end of the pond, near the houses; and, at the same time, the borders near by, which are covered with water in the late winter, spring, and early autumn, are exposed to a very considerable width. At the angle of separation of the northerly and easterly banks, at this time, is situated a pool of water, at least an acre in extent, which is stagnant and filled with growing, rank vegetation. More than thirty years ago, a canal was built by owners of certain mill-property on the Monatoquot River, connecting the pond with the river; the object being to supplement the water-supply in times of drouth, and in midsummer. Two weeks are required to allow as much water as will, to flow out of the pond. This year (1875) the water was lowered five feet.

"Thirty years ago, there was scarcely a case of typhoid fever known in the town; whereas it was not an uncommon disease in the neighboring town of Randolph. In the last ten years, there have been here many cases of typhoid fever; every year a greater or less

number, in times of drouth. Till then, on the northerly border, the town was but little built up.

"The cellars of the houses of the greater portion of the town are apt to be damp; though a complaint of flooding of the same, has not been made. The water-supply is by means of wells for the individual houses, and the privies are in most cases detached from the houses, and not very near the wells; no case was found where the drain from the kitchen-sink was near the well. No unusual taste, as of sewage, has been noticed in the water of the wells connected with the houses where the diseases were most prevalent. The house where five fatal cases of cerebro-spinal meningitis occurred, was inhabited by three families, all rather filthy about the house. The people in the diseased locality kept their windows towards the pond open. Every evening in the autumn, from the middle of July to October, near the southern and eastern sides of the pond, the air was strong, with a peculiar bog-smell. In September, this year, it had been in that state, and was getting worse when the cases of typhoid came on. All appeared within a fortnight of each other, and in September.

"The memory of the reporter alone is depended on for these cases, and it was not accurately determined, whether or not defective water, etc., might have been at fault.

"The accompanying map illustrates the main points in the matter. The figures are explained in the following table:—

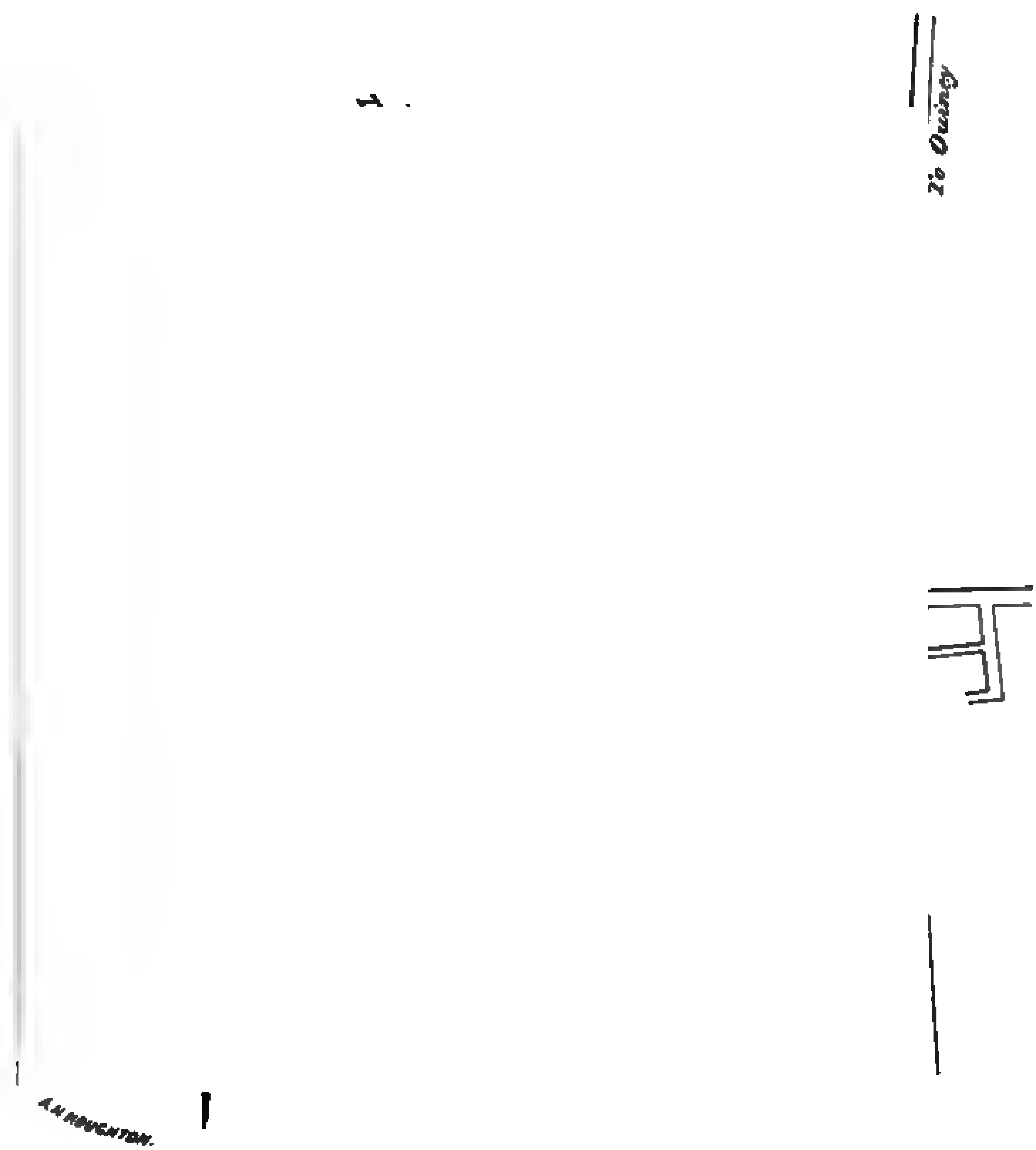
"1. Two cases of typhoid fever this year,—one fatal.
2. Three years ago, three cases of typhoid fever,—two fatal.
3. One case of typhoid fever this year,—with recovery.
4 Two fatal cases of pneumonia last year.
5. Five fatal cases of cerebro-spinal meningitis, two years ago.
6 No tenants in summer months.
7. Two cases of typhoid fever, with recovery, this year.
8. One fatal case of typhoid, year before last.
9 Two fatal cases of typhoid this year.
10. Church twenty feet above level of water.
11. Islands at low water.
12. Stagnant and filthy at low water.
13. School-house."

Winchester.

The following account of the successful use of a gathering-ground as a source of water-supply, is given as furnishing information which may be of service to other towns.

Winchester (containing a population of 3,099) lies in the valley of the Mystic waters, the upper end of Mystic Pond

SOUTH BRAINTREE.



being within the southern portion of the town. It is partly in the valley-bottom, but mainly on the slopes of the bordering hills.

In 1872–3, there was appointed a committee to investigate and report upon the best means of securing a public water-supply. The necessities of the case seemed to restrict this committee to sources from which water must be raised by pumping, with all its attendant expenses, till it was suggested that on the top of the hills on the eastern side of the town there was a valley, in the neighborhood of which there were no buildings, and which might prove to collect from a rain-shed of sufficient area to supply the town by gravity flow. Examination was made and resulted in the selection of this locality for a storage-reservoir. The valley was drained by a small brook, never known to be dry more than two or three times in the last twenty-five years.* At its outlet the valley narrowed, so that only a comparatively short dam was needed. The engineers' levels showed that but forty dwellings in the town were above the head of the proposed reservoir. The depth of vegetable mould nowhere exceeded eighteen inches. This, with all shrubs and trees, was removed over an area of sixty acres, which was underlaid by hard-pan and ledge. The dam has a length of 675 feet; its greatest width is 130 feet; its width on the top is 13 feet; the greatest height is 30½ feet.

The area of the reservoir is sixty acres; its length, 4,400 feet; greatest width, 1,450 feet; greatest depth, 23 feet. Since its construction the depth of water at the inlet-pipe (from reservoir to gate-house) has never been less than 15.87 feet. The total capacity of the reservoir is 259,000,000 gallons; which is capable of supplying daily at least 800,000 gallons, although the town does not now use one-quarter of that amount. The flow from reservoir to gate-house is so arranged that it can be taken at any point from the bottom to the surface of the water. During the first forty-eight days after water began to be stored (December 5, 1873 to January

* It was wholly on the known "rainfall to the acre" in Massachusetts, that the advocates of this plan based their confidence as to quantity, while as to quality they trusted to the fact that no source of pollution existed on the gathering-ground, or rain-shed.

22, 1874), 79,000,000 gallons were collected, and during the next thirty-six days, 53,000,000 gallons more were allowed to run to waste. The water-shed has an area of 425 acres. In quality this water will compare favorably with any in the Commonwealth. Its quantity can be doubled by uniting with it another similar gathering-ground in the immediate neighborhood. The entire cost, including thirteen* miles of main pipe, has been $161,377, and this, be it remembered, is a *gravity* supply.

Worcester.

"Our water-supply is from a reservoir fed by Lynde Brook. It is generally considered that the health of the community has been improved since its introduction, although there are no available statistics to prove the fact.

"The sewered area includes the best part of the city; and, so far as it goes, our sewerage is satisfactory. The sewage is discharged into Mill Brook, which, for a long distance, has been converted into the main sewer. High water causes a backing-up at the outlet, and this locality is often very offensive. The spot is sparsely inhabited, and I know of no bad results to health traceable to this cause.

"In portions of the city where there are no sewers, arrangements for the disposal of filth are in part very primitive,—such as privies without excavation and surface disposal of sink-drainage. In other parts there are good cesspools. Some of the first-named localities are often and strongly offensive, and wells are, in some cases, exposed.

"In one house, I have this season attended both parents and one child with typhoid fever. Their well is twenty feet deep and thirty feet from the cesspool,—a shallow, unlined excavation. It is also twenty-five feet from the barn-cellar, where a sink-drain from the house discharges upon a small pile of manure. In another part of the city the filth from a long row of houses is thrown into a small branch of Mill Brook, turned for manufacturing purposes from the main channel, and rejoining it lower down. This region is perhaps the most sickly of the city, although there are other reasons also therefor.

"The outlet of our sewers is, properly speaking, that point where the main becomes an open stream, which it does in the city itself. For three-quarters of a mile it is open, has never been complained of so far as my knowledge goes, and is not supposed to have

* There are now fifteen miles, but the additional expense I do not know.

had any noticeable deleterious effect upon health. This sewer is eighteen feet wide and four to ten feet deep, straight in course, with a fall of one foot in one thousand. Its walls are built of stone, with a curved, paved bottom. It drains over sixteen miles of sewers. It is merely a new straight channel for Mill Brook. The old channel has not been entirely disused; a part of the water is still allowed to pass a break in the sewer-wall, and to follow its old winding course through a district called the 'Island,' thickly covered with tenement houses. This old channel still receives a large amount of sewage from privies placed over it, sink-drains, etc., and furthermore is the outlet for fourteen miles of sewers. Under these circumstances, the city is unable to shut off this stream without immediate very large expenditure in extending the system of sewers.

"As to what has actually been the effect of the present state of affairs upon the public health, there is no testimony of value."

The following extracts are from the printed report of C. H. M. Blake, C. E., City Engineer, Worcester, Oct. 25, 1875:—

"About thirty acres of the Island district are extremely low, and not more than three and a half feet above ordinary water level of the Blackstone River at the outlet of the Mill Brook sewer. To drain this territory by gravity at that point, under existing circumstances, is impracticable; cellars that are now flooded during high water would not be relieved.

"The following schemes for accomplishing the object desired are submitted for consideration: First, by the passage of a grade-law, regulating the grades at which cellars and streets shall be built to insure perfect drainage. The expense of grading and raising buildings already constructed would be excessive, in comparison with other schemes.

"The second scheme contemplates the purchase of a portion of the water-rights of the Washburn & Moen Manufacturing Company, at Quinsigamond Village, and taking down about five feet of their dam at that point. This would insure proper drainage of the district, but is open to serious objections. The outlet of Mill Brook sewer is at present into a mill-pond; during low stages of water a portion of the bed of the stream is uncovered and exposed to the action of the air, the sewage-matter deposited undergoes a chemical change, which is offensive, and, in the future, as the population of the city increases, will become more so. To prevent the nuisance, it would be necessary to wall the channel of the river so as to contract the flow during dry weather, and prevent this deposit from taking place.

"The cost of this, added to the cost of water-rights to be acquired, would exceed the expense of the third scheme; which is, to carry a sewer to a point below the dam at Quinsigamond Village for an outlet. A sewer of the requisite capacity to carry the storm water of the Piedmont and Island districts would be of sufficient size to take the ordinary flow of Mill Brook sewer, in addition to the dry weather flow of the above districts. By an arrangement of gates, the dry weather flow of Mill Brook could, if desired at any time in the future, be diverted and carried below the dam, the waters during the wet season being discharged directly into the river, as at present.

"Another advantage of the third scheme is, that in case any of the numerous chemical processes on trial in Europe for the purification of sewage should prove practicable, or if irrigation or filtration should be resorted to as a means of purifying the effluent water, the sewage, during a large portion of the time, could all be concentrated at one point by gravity, where it could be dealt with at the greatest advantage. During freshets, no evil effect would ensue from the discharge of the Mill Brook sewer directly into the river."

At and below Northbridge, which is about fifteen miles below Worcester, neither the people living along the Blackstone River, nor the manufacturers, so far as could be learned, are annoyed by the condition of the water.

Analysis of Various Waters.

Most of the chemical examinations given in this paper were made under the direction of Professor Nichols, in the laboratory of the Massachusetts Institute of Technology. The methods of analysis employed have been already stated on page 174.

In interpreting the results of the examination of a well-water, the most complete satisfaction would be gained by a comparison of the water of the well with what might be called the normal well-water of the particular region. Indications which would be proofs of contamination in one locality would awaken no suspicions in another.

For example, the natural waters in most places in this State are almost free from compounds of *chlorine*, which occurs in small amount in all waters, most often as chloride of sodium or common salt. Therefore, if any amount, at all considerable, of salt is found in a well-water not near the sea, it has come in some way or other from human sources,

and awakens suspicions of drainage. It may come from salt actually thrown into the pump in winter to thaw ice which has formed, or salt may have been applied on the surface of the ground to kill weeds. In each case its presence is accounted for naturally. More than one part of chlorine in 100,000 (0.6 grain per gallon) should awaken suspicion.*

The presence of *ammonia* or of nitrogenous organic matter, which is indicated by the "*albuminoid ammonia*," in a well-water to the amount in either case of 0.01 part in 100,000 (0.006 grain to the gallon), would point to the fact that the well was polluted by drainage, and even half that amount might awaken suspicion.

In the case of well-waters, little can be learned from what is called "organic and volatile matter"; more than three parts in 100,000 would certainly be ground for suspicion.

The presence of nitrates is generally proof that some drainage matters, or rather the products of their oxidation, reach the well. If the nitrates are accompanied by nitrogenous organic matter (as shown by the "albuminoid ammonia"), there is evidence that the well receives *fresh* drainage.

Water from streams or ponds must be very differently judged, and unless distinctly *bad*, cannot be passed upon by chemical analysis *alone*. Their borders and immediate watersheds must be carefully inspected. If they flow through or drain peaty soils, or contain "vegetable extractive matter," they will show under analysis more ammonia than belongs to a safe well-water, without falling under suspicion of contamination by drainage. On the other hand, there is normally very little chlorine in the water of streams and ponds, and, if we find the proportion of this approaching the limit named as safe in well-water (1.00 part in 100,000), we may be confident that it arises from sewage of some kind.

The fact that a water is clear and palatable is no proof whatever of its purity, these conditions being markedly present in some well-waters shockingly polluted with sewage, as shown both by ocular inspection and chemical

* The normal presence of considerable quantities of salt in the water of wells near the sea, is, of course, not to be overlooked. In a well examined at South Scituate, the chlorine, thought to be due chiefly to the immediate vicinity of the sea, amounted to nineteen parts per 100,000.

analysis; and further, a water may be found by the chemist to be fouled by sewage, and yet neither he nor the microscopist be able to say whether it carries the specific poison of certain diseases; for example, typhoid fever and cholera.

WELL-WATERS.

The following table contains the results of the chemical examination of well-waters received from various correspondents of the State Board of Health; others were examined, but, as they present no points of interest, they have been omitted.

Examination of various Well-Waters.

[Results expressed in Parts per 100,000.]

Number.	Date.	Locality.	Ammonia.	"Albuminoid Ammonia."	Solid Residue. Inorganic.	Solid Residue. Organic and Volatile.	Solid Residue. Total at 212° Fahrenheit.	Chlorine.	Oxygen required to oxidize organic matter.	Nitrates.	Lead.
1	Aug. 24, 1875,	Belchertown, ...	0.0059	0.0044	20.76	1.80	22.56	3.56	0.11	Trace.	-
2	" 10, 1875,	Chicopee, ...	0.0027	0.0069	45.92	4.60	50.52	11.72	0.08	Some.	-
3	" 31, 1875,	Clinton, ...	0.0048	0.0072	28.68	14.88	43.56	5.26	0.13	Trace.	0.99
4	Dec. 9, 1875,	Lowell, } same well, .	0.1400	0.0140	*	*	77.20	20.60	-	Large amount.	-
5	" 27, 1875,	Lowell, } same well, .	0.1700	0.0140	*	*	69.92	15.50	-		-
6	Sept. 9, 1875,	Malden, ...	0.0059	0.0187	33.95	4.25	38.20	5.40	0.36	Considerable.	-
7	Aug. 24, 1875,	Milford, ...	0.7253	0.0395	40.28	8.20	48.48	8.62	0.16		Trace.
8	Sept. 13, 1875,	Taunton, ...	0.0037	0.0093	28.32	2.80	31.12	3.20	0.19	Trace.	-
9	" 13, 1875,	Taunton, ...	0.1066	0.0136	43.12	1.80	44.92	10.20	0.15	Trace.	-

* The determination of the so-called "organic and volatile matter,"—that is, the loss on ignition,—would be of no value whatever in the presence of so much chlorine; the determination is of little value in most well-waters.

The following facts, with reference to the well-waters mentioned in the preceding tables, have been gathered from the letters of the various correspondents, and from Professor Nichols' reports :—

No. 1. *From Belchertown.* "There have been more cases of typhoid fever and diphtheria in the house where this well is, than in any ten, and I think twenty, houses I know of. I can see no reason for this, unless it is the water, and have reason to think this may be the cause.

"I should say the well probably receives indirect drainage, but cannot find *in the results of examination* anything to account for the sickness described."

No. 2. *From Chicopee.* "From a well in a house, where several cases of typhoid fever occurred this summer, and several cases a year ago, in the same house; a filthy yard, with bad drainage, we were satisfied was the principal cause, and believed the well was more or less contaminated. The yard has recently been drained."

No. 3. *From Clinton.* "I have several cases of lead-disease in families in the vicinity of the well."

Nos. 4 and 5. *From Lowell.* The drainage and sewerage of Lowell are as yet incomplete, and, in parts, very defective; and "filth diseases" are reported from the correspondent of the Board as being frequent in such localities.

"The water is from a well which is boarded over. Spittoons have been cleaned on the boards, and sink-water has been poured on the surface of the ground, about two or three feet from the well. The water is said to be hard, and all who have used it think it has a disagreeable taste.

"The first specimen, No. 4, of the water was taken when the condition of things was as just described. The second specimen, No. 5, was taken three weeks after the direct accession of fluid refuse had been stopped.

"The water, although clear to the eye, was offensive to smell and taste, and utterly unfit for domestic use. The second specimen was, in essential particulars, scarcely better than the first."

No. 6. *From Malden.* This would be pronounced a bad water.

No. 7. *From Milford.* "My attention was called to the condition of the water, while attending a case of sickness. . . . . The well is located within the village, in low ground; is partly covered by a grocery store and partly under the street; has three lead-pipes entering it to supply families, . . . but is not supposed to be contaminated. The well has been used for the past seven years.

"This water is chiefly remarkable on account of the very large amount of ammonia. The water is not fit for domestic use."

Nos. 8 and 9. *From Taunton.* The subsoil water of the denser portion of Taunton is probably considerably polluted, as the city is situated on flat ground, and has no complete system of sewerage. This was shown by an examination of water from a number of wells made by Professor Nichols for the city of Taunton, and by the examination of the two samples, Nos. 8 and 9, reported in the table. Neither of these waters is desirable for domestic use, and No. 9 is positively bad.

The New Water-Supply of Springfield.

The new water-supply of Springfield is derived from a reservoir in the town of Ludlow, known as the Cherry Valley or the Ludlow Reservoir. A specimen of water taken from the reservoir, near the outlet, was sent for chemical examination, and the results are incorporated in the table which follows. The chief peculiarity was the presence of a large amount of vegetable matter. The water was filled with particles of a green substance, which proved on examination to be a species of vegetable, an alga belonging to the Nostoc family. The water, in the condition of the specimen sent, would seem undesirable for domestic use. Subsequently, Prof. Nichols visited the reservoir in company with the engineer, Mr. Phinehas Ball, of Worcester, and specimens of water taken under direction of Mr. Ball from different localities were examined. The results are recorded in the following table. Prof. Nichols' remarks on the condition of the reservoir were as follows:—

"The Ludlow Reservoir, from which the city of Springfield proposes to take its supply of water for domestic use, is formed by damming up several brooks, tributaries of the Chicopee River. The details of the location and construction of the reservoir, are given very fully in the report of the board of water commissioners of the city of Springfield, 1875. The reservoir covers an area of about 450 acres. Much of the land on which it is built was under a good state of cultivation, as pasturage, grass and tillage land. On the southern and south-eastern sides are large areas of gravelly and sandy soil, and some 280 acres were covered with wood in various stages of growth. A portion of the timber-land was on a swampy bottom. The shores of the reservoir are of an unobjectionable character. In preparing the reservoir for flooding, the timber and brush

were cut down and the ground burned over, the stumps which were left standing being thoroughly charred. A portion of the swampy area was covered with sand and gravel. The reservoir is now (September 7) mainly completed, but not yet full; it will fill during the coming winter. The water was collected to the present height in the spring, and the amount used and that lost by evaporation have been equal to the supply. Hence, there are about 100 acres of the muddy or swampy bottom now covered with only a few feet of water, where, after the reservoir is full, there will be from 12 to 16 feet of water; there will then be only a few acres (perhaps 25) of shallow water, and that will be at the upper end, where the bottom is good. The water is now used for watering streets, and for watering cattle, etc., in Springfield. It is also supplied to a limited part of the city for domestic purposes. The water had a marked, peculiar taste and odor of green corn, which seemed to be closely connected with, if not caused by, the vegetable growth which was observed. The chemical examination of the water showed the presence of a large amount of nitrogenous organic matter, a considerable portion of which is to be ascribed to the decaying of vegetable matter. I think, however, this is a temporary condition of things which will very sensibly improve as time passes. With reference to the living vegetable matter already alluded to, it is to be said that there will probably never again be so favorable an opportunity for the growth of low orders of animals and plants as was presented this summer in the large amount of shallow water exposed to the sun's rays. . . It will further appear from the table, that the water dissolves a considerable amount of mineral matter from the cement-lined service-pipes. This is, however, no serious matter, and probably the proportion so dissolved will be less after the pipes have been longer in use."

The results of the examination of specimens of water, collected in December, 1875, and January, 1876, are published in the second report of the water commissioners, and are introduced into the accompanying table.

The reservoir is now nearly full, and it will be seen that a great improvement has taken place. The water is now nearly free from suspended matter, and without any disagreeable odor or taste.

Examination of Water from Ludlow Reservoir.

[Results expressed in Parts per 100,000.]

Number.	Date.	Locality.		Ammonia.	"Albuminoid Ammonia."	Solid Residue. Inorganic.	Solid Residue. Organic and Volatile.	Solid Residue. Total at 212° Fahrenheit.	Chlorine.	Oxygen required to oxidize organic matter.
	1875.									
24 M	Sept. 2,	Between filter-dam and gate-house,	Unfiltered,*	0.1227	0.3627	4.20	10.72	14.92	–	–
			Filtered,*	0.1333	0.0773	3.92	3.56	7.48	–	1.37
26 M	" 9,	Midway between filter-dam and gate-house,	Unfiltered,†	–	–	3.36	3.68	7.04	–	–
			Filtered,†	0.1066	0.0666	3.48	3.44	6.92	0.24	1.39
27 M	" 9,	Middle of reservoir,	Unfiltered,†	–	–	2.72	4.48	7.20	–	–
			Filtered,†	0.1040	0.0666	2.96	3.92	6.88	0.22	1.43
28 M	" 9,	Service-pipe, Indian Orchard,	Unfiltered,†	–	–	6.68	3.84	10.52	–	–
			Filtered,†	0.1333	0.0660	6.32	3.88	10.20	0.34	1.51
29 M	" 9,	Service-pipe on hill,	Unfiltered,†	–	–	7.16	3.68	10.84	–	–
			Filtered,†	0.1066	0.0720	6.40	3.76	10.16	–	1.48
32 O	Dec. 25,	Reservoir near entrance of Broad Brook,‡		0.0084	0.0172	3.60	2.16	5.76	0.20	0.82
33 O	" 25,	Middle of reservoir,‡		0.0162	0.0314	3.52	2.88	6.40	0.21	1.31
34 O	" 25,	Between filter-dam and gate-house,‡		0.0162	0.0320	3.36	2.92	6.28	0.22	1.45
	1876.									
36 O	Jan. 17,	Middle of reservoir,‡		0.0126	0.0316	2.64	2.44	5.08	0.20	1.33
38 O	" 17,	Middle of reservoir, second sample,‡		0.0152	0.0318	2.40	2.64	5.04	0.20	1.49
37 O	" 17,	Between filter-dam and gate-house,‡		0.0120	0.0340	2.46	2.98	5.44	0.20	1.29
35 O	" 17,	Broad Brook,‡		0.0066	0.0128	3.14	1.88	5.02	0.20	0.89

* Collected by Dr. Smith, Granby. † Collected under direction of Phinehas Ball, Esq., Engineer of the Springfield Water-Works.
‡ These examinations were made for the city of Springfield. The water was collected by, or under direction of, Mr. Ball.

The Pittsfield Ice-Supply.

Nearly all the ice used here is cut on "Silver Lake," which is about twenty acres in extent, and situated to the eastward of the more thickly-settled portion of the town. Its outlet into the Housatonic River ordinarily discharges but little water, and the flow is sometimes even toward the lake, which is fed by springs and a small brook, which takes its rise in Frog Pond, about half a mile to the north. The sources of pollution on the brook are several dwellings and two factories, —the one discharging a small amount of refuse dyestuff from silk-works, the other emptying the overflow of a cesspool for water-closets, used by one hundred and fifty employés. According to Dr. Adams, health officer of Pittsfield, the water is sometimes quite foul in appearance, but oftener comparatively clear. Looking upon this source of pollution with some suspicion, he sent specimens of water for analysis. Prof. Nichols afterwards visited the locality, at the request of the Secretary of the Board, and obtained several more. From the results of analysis, it will be seen that the ice is considerably purer than the water of the pond, thereby showing that the process of freezing does tend, to a considerable degree, to purification. Chemical examination alone does not indicate that the ice is unfit for domestic use, nor does it ordinarily detect a very slight degree of pollution, which may be offensive to our sense, from the fact that we previously knew of its presence.

Considering the great dilution of filth which may often take place without securing immunity from disease consequent upon taking such filth into the system, there can be no question as to the propriety of putting a stop to this contamination at once, especially in view of the fact that it is likely to increase rather than diminish.

The large amount of inorganic matter is thought, by Prof. Nichols, to be due to mineral salts dissolved in the waters of the springs, which indeed have been found hard and unfit for use in boilers.

There are a few dwellings, and a shoe-factory, on the borders of the lake itself.

Examination of Water from Pittsfield, Mass.

[Results expressed in Parts per 100,000.]

Number.	Date.	Locality.	Ammonia.	"Albuminoid Ammonia."	Solid Residue. Inorganic.	Solid Residue. Organic and Volatile.	Solid Residue. Total at 212° Fahrenheit.	Chlorine.
74	Feb. 21, 1876,	Frog Pond,[1]	0.0072	0.0212	2.64	2.44	5.08	0.04
75	" 21, 1876,	Brook,[2]	0.0180	0.0120	18.08	2.28	20.36	0.36
67	" 16, 1876,	Brook,[3]	0.0140	0.0180	9.58	2.78	12.36	0.21
58	Nov. 21, 1875,	Brook,[4]	0.1400*	0.0348	16.64	4.64	21.28	0.67
68	Feb. 16, 1876,	Brook,[4]	0.0060	0.0156	9.06	2.84	11.90	0.18
59	Nov. 21, 1875,	Lake,[5]	0.0210	0.0200	10.28	2.60	12.88	0.26
69	Feb. 16, 1876,	Lake,[5]	0.0180	0.0152	10.32	2.72	13.04	0.30
70	" 16, 1876,	Lake,[6]	0.0220	0.0140	11.92	2.60	14.52	0.35
71	" 16, 1876,	Lake,[7]	0.0200	0.0136	11.60	2.68	14.28	0.38
76	" 21, 1876,	Ice from lake, Unfiltered,	0.0072	0.0061	0.93	0.58	1.51	–
		Ice from lake, Filtered,	0.0077	0.0013	0.30	0.14	0.44	0.02
72	" 16, 1876,	Housatonic River,	0.0042	0.0089	4.84	2.64	7.48	0.11

* Unfiltered gave ammonia, 0.1400; "albuminoid ammonia," 0.0520.

[1] Taken near the middle of the pond.

[2] Taken at Lincoln Street bridge, some distance above silk factory.

[3] Taken just above drain from silk factory.

[4] Taken between silk factory and lake.

[5] Taken at eastern end of pond, midway between north and south shores, at surface.

Taken at same point, near bottom, fifteen feet from surface.

[7] Taken from bottom of pond at west end, thirteen feet from surface.

III.—THE DISPOSAL OF SEWAGE.

By C. F. Folsom, M. D.

Introduction.

After the loss of the water-closet in the destruction of Pompeii, the disuse of the bath upon the overthrow of the Latin civilization, and the entire oblivion of the lessons taught by the sewers of Rome, Jerusalem, Pompeii and Nineveh, human filth was allowed to accumulate around the towns and cities of Europe until the inhabitants, in seasons of unusually bad climatic influence, were decimated by the black death * and the plague. They were taught their first lessons in sanitary science by their Mohammedan enemies, and more attention to cleanliness made the two dreaded diseases almost unknown.

In modern times it has been easy enough to think that in the darkness of the Middle Ages people poisoned themselves with their own filth, and therefore suffered terribly from the ravages of preventable disease; but all communities have been slow to believe that the more familiar diseases, like scarlet fever and typhoid fever, which they had been in the habit of considering more or less inevitable, were perhaps not equally preventable with cholera and typhus, but still preventable to a very great degree; and it was with surprise that people not educated in medicine heard, during the past year, that one of the first authorities now living had described a large class of maladies as "filth-diseases." †

It has been difficult to explain why an intelligent appreciation of disease, and a reasonable knowledge of the ordinary means of its prevention, have been so slow in forcing them-

* Hecker [Epidemics of the Middle Ages] estimates that in the first epidemic of the fourteenth century this disease swept away one-fourth of the total population of Europe; other writers place the mortality at a still higher figure.

† Second Report of the Medical Officer of the Privy Council, new series. London, 1875; reprinted by permission of the author, Boston, 1876.

selves upon the attention of all communities. Nearly three-quarters of a century passed in England, after the discovery of the means of preventing the scurvy, before they were sufficiently appreciated to be used in the royal navy; and only a year ago it was preached from one of their pulpits that the severe epidemic of scarlet fever in London was a visitation from God for the sins of the wicked metropolis. The small-pox epidemic of 1872 found most of our cities in America entirely unprepared to meet it; and it was only with great difficulty, and against much opposition, that proper steps were taken to control the disease.

For the past third of a century, however, more persistent efforts than ever before have been made to improve the health of the people; the social economist has outdone the novelist in his computations of the suffering and misery, the waste and loss to society, arising from this cause, that might be avoided;* and the statistician, with his estimate of twenty to twenty-eight cases of illness for every death, has added his warning. Much has already been done; human life has been prolonged; diseases that formerly were common have disappeared, while others have materially diminished, all from a better attention to cleanliness.

Complicated as has been the sanitary legislation of different countries, it resolves itself chiefly into the broad principle of attempting to provide clean air, clean water, clean food, clean soil, clean houses. It is not to be understood, however, that any *general* attention to cleanliness, in the ordinary acceptation of the word, will secure entire immunity from the preventable diseases. The special *kinds* of cleanliness necessary to avoid the different fevers, for instance, are quite different one from another, and cannot be fully practised without an intimate knowledge of the way in which each disease is propagated.

Twenty-five years ago, preventive medicine consisted in trying by quarantine to keep out disease: now it consists chiefly in removing the conditions favorable to its existence and spread. The Act appointing the Central Board of Health in London recognized this fact, and stated that "the measures

* See Dr. Richardson's lecture, "A Model City of Health," delivered before the British Social Science Association, in Bristol, October, 1875.

of extreme precaution for preventing the introduction of the cholera by a vigorous quarantine, have hitherto been found inefficient." Pettenkofer puts the matter still more forcibly. He compares the outbreak of cholera to explosions from gunpowder. The sparks which set fire to the powder are the "germs" of the disease, which we cannot keep out by the most rigid quarantine; the powder is the combination of local circumstances in a town or city, without which the disease cannot get a foothold. He says that we "act more wisely in searching out and removing the powder itself, than in running after and trying to extinguish each individual spark before one of them drops on a powder-heap, and causes an explosion which blows us into the air with our extinguishers in our hands."

The general intelligence of any community may be safely inferred from the attention which they pay to removing all filth—one link, at least, in the chain of disease which we *can* control—completely away, beyond the possibility of doing harm.

The Effect of Filth on Health.

Dr. William Stokes, one of the first authorities in sanitary science, says: "Sewers, streams, rivers and damp localities, collections of refuse,—not alone of putrefying animal and vegetable matters, but of materials in no way offensive,—have been in turn accused as having been manufactories of disease, not of cholera alone, but, in an enterprising mercantile spirit, of a great variety, so as to suit the market."*

Dr. Pratt says of a district in the north of Ireland: "If dirt alone was the common generator of fever, the country would long since have been desolated from sea to sea;" whereas fever is there almost unknown. In one place in that country four thousand persons were found living on twenty-five acres of land, each house having its dunghill, and even the lower rooms of some of them being filled with manure; yet the health of the town has always been good.†

* Lecture on Sanitary Science, 1873.

† Probably no one cause is more prolific of disease than density of population, with its concomitant evils, the greatest of which is, usually, incomplete removal of filth. This is shown, with remarkable force, by the statistics of

Dr. Graves says: "Filth is the outward and visible sign of poverty, and, like poverty, is an evil in itself; it oftener accompanies than causes disease; otherwise, as I have said, every capital in Europe would contain within its precincts many self-supporting manufactories of pestilence. I have always been of opinion that poverty is more injurious to

England for the different registration districts, in the decennial period from 1851 to 1860.

Table showing the effect of Density of Population on Death-rates in England.

Number of Districts.	No. of Acres.	Average Population.	No. of Persons to each square mile.	Annual death-rate per 1,000.
1, ...	238,861	6,817	18	14
2, ...	301,473	21,069	45	15
12, ...	627,588	129,005	132	16
26, ...	1,507,484	421,140	179	17
81, ...	5,258,236	1,300,629	158	18
121, ...	9,540,681	2,668,756	179	19
129, ...	8,444,479	2,649,736	201	20
84, ...	5,599,983	2,110,379	241	21
51, ...	2,636,106	1,878,056	456	22
40, ...	1,514,137	1,845,790	780	23
26, ...	590,955	1,762,962	1,909	24
20, ...	442,540	880,953	1,274	25
14, ...	217,029	1,065,319	3,142	26
13, ...	212,694	1,085,675	3,267	27
11, ...	195,673	1,170,740	3,830	28–33
Total No. of Districts, 631, ...	37,324,883	18,997,076	362	22

The fallacy, however, of trying to explain high rates of disease or death by any one cause, is well shown, in connection with this table, by the experience of Glasgow and Greenock, two Scotch cities only forty miles apart. For the ten years ending in 1871, the average death-rate per 1,000 of Greenock was 33.6, against 30.6 in Glasgow, in spite of the facts shown here in tabular form:—

City.	Total Population.	Population, per acre.	Population, per house.	Daily water-supply per person, in gallons.
Greenock, ...	59,785	24.4	27.4	53.6
Glasgow, ...	477,710	94.9	32.5	54.0

This simply shows that other causes of disease may be so potent as to overbalance that of density of population. Greenock, the port of the Clyde, naturally has a larger proportion of the improvident classes than Glasgow; its sewerage is in a much worse condition; it is much more exposed to sea-winds; it has a rainfall sixty per cent. greater, and, in proportion to its population, has two and a half times as many cellars used for lodgings.

health than dirt; that its prevalence entails disease,—sporadic disease,—from many obvious causes, and increases its spread."

There is among men a tendency to attribute complex phenomena to a single cause; and, much as we have learned with regard to the "preventable diseases," there is still too much truth in the statement that "the causes of epidemic diseases escape the scrutiny of both nostrils and vision."

Virchow thinks* that ordinary putrefaction may, under certain circumstances, all of which are not known, produce some of the zymotic diseases, especially typhoid fever and dysentery. Pettenkofer holds that a specific poison exists for those diseases, and that each disease can be produced only by its own virus or germ. In England, where Pettenkofer's theory of the relations of the variation in the level of the ground-water to typhoid fever and cholera has not received general support, opinion is divided, as it is on the continent of Europe, as to the question whether disease is produced by filth alone, or by filth *plus* some particular poison. Continuing the comparison previously cited, Pettenkofer likens urban filth to the charcoal in gunpowder. *It is necessary to have it, in order to produce the explosion;* but the sulphur and saltpetre must be there, too, and the mixture must be in the right proportions; otherwise, the spark produces no fire.

Liebermeister's opinion† seems to be gaining ground; namely, that filth furnishes a favorable *nidus* in which disease finds favorable conditions for rapid development.

The fact, however, stands unquestioned, that in some way or other removal of filth lowers death-rates. Berlin and Munich, the filthiest and most scientific of the German cities, deserve Traube's sarcasm of not being able to stop the cholera, even in winter,—a more or less continuous epidemic, so to speak, having lasted since 1866; while in London and Paris, the cleanest of large cities, the last epidemic (in 1866) fell very lightly, and the death-rates are one-third lower than in Munich and Berlin. In Hamburg and Dantzic, the only German cities where systematic sewerage-works have been completed for several years, the increased cleanliness

* This subject is fully and exhaustively discussed by him in his lecture on "*Die Fortschritte der Kriegsheilkunde.*" Berlin, 1874.

† "Zur Aetiologie des Typhus." *Deutsche Klinik, February* 17, 1866.

has reduced the mortality in a great degree. In Dantzic, typhoid fever has become chiefly a disease of the suburbs, where there are no sewers.

In England, the reports of the medical inspectors to the medical officer of the privy council have contained such searching investigations of the causes of disease, and their connections with filth, as to give to at least one branch of medicine the title of an exact science. One of the most striking of these papers,* by Dr. George Buchanan, shows the improvement to health from drainage, sewerage and water-works, in twenty-five cities and towns, with an aggregate population of 593,736. The average of the death-rates per 10,000 for the different places had decreased as follows :—

From all causes,	from	247.55	to	219.87
typhoid fever,	"	13.34	to	7.8
diarrhœa,	"	8.45	to	7.66
pulmonary consumption,	"	33.44	to	27.3
Among infants under 1,	"	55.65	to	50.

The average number of years for which the death-rates were calculated, were, before improvements, seven and one-half; after them, six and five-eighths.

Dr. Buchanan's final conclusion from his investigations was, that the progress made by the inhabitants of most of the twenty-five towns, in decency, cleanliness, self-respect and morality, was, at the least, as striking as the improvement in the health, measured by the mortality returns. The increased self-respect and improved general condition, undoubtedly led them to a juster appreciation of disease, and of measures to prevent it.

In some of these towns, it was found that improper construction or ventilation of the sewers had been the probable cause of increasing the death-rate, by exposing people to the direct effect of deleterious gases.

The Influence of Sewer-Gases on Health.

With regard to the effects of sewer-poison, it is found that its virulence depends in some measure on the age, condition,

* Ninth Report of the Medical Officer of the Privy Council, p. 50.

habits and employment of the persons exposed to it, and also upon the freshness of their exposure. Many facts go to show that an atmosphere may be tolerated in working hours which would produce serious disease if breathed when the system is in the non-resistant condition of sleep. In the same way, when the system is fresh, in active exercise, and well nourished by abundant food, one may safely expose himself to a degree of contamination of the air which would be thoroughly unsafe if the various organs of the body were relaxed by sleep, fatigue, or even a posture of rest.* Illustrations of this fact are numerous. Carpenter states that a large number of children in one of the English workhouses were twice attacked with severe diarrhœa from exposure to the emanations from a manure factory, while the workmen had good health. Murchison relates that in a school at Clapham, twenty out of twenty-two boys were seized with violent vomiting, purging, prostration and fever, within three hours after exposure to foul sewage-emanations rising from a sewer which they had been watching the workmen clear. None of the men became ill.†

It is undoubtedly the same with regard to sewage-emanations in and near our dwellings. The strong, the active, the well, and those who spend a large part of the day away from their houses, do not ordinarily suffer. In the great epidemic of typhoid fever at Croydon, in 1853, caused by sewer-gases in the houses, "we found servants chiefly attacked, and then children; the fathers were very seldom sick at all, because they were not much at home, while the others were usually at home."‡

It is most often from long-continued exposure, or when some depression of the vital powers exists, that disease is caused by a sewage-poisoned atmosphere, unless the poison be very concentrated.§

* These facts are well known to inhabitants of malarious districts. They do not hesitate to walk or ride, especially after eating, through regions where they could not sleep, or even drive, with impunity.

† The six hundred workmen in the thoroughly-ventilated sewers of Paris are generally exempt from zymotic diseases, as has been shown by severe epidemics in the city at various times. They suffer chiefly from chronic diseases, indicative of slow rather than rapid poisoning.

‡ Evidence of Dr. William Sunderland.

§ A number of authentic cases show the danger of these poisons when con-

It is a well-known fact, too, that by long use we are able to tolerate certain conditions unfavorable to health. This really means, however, in a large proportion of cases, that the injurious effects are so gradual in their manifestation that we do not appreciate them.

The influence of sewage upon the water-supplies of cities, has already been fully considered in previous pages of this Report. A few words will be in place here in regard to the chances of contracting disease from drinking such water, after it has been subjected to the various processes of purification, etc.

WATER CONTAMINATED BY SEWAGE.

It has been stated by an eminent English authority, that streams become purified by a flow of twelve miles if not more than one-twentieth part of their volume has been made to consist of sewage; and that it is safe to drink sewage-contaminated water after filtration.

Much, indeed, has been said as to the complete self-purification of rivers by a flow of a few dozen miles. No such power exists. The solid parts are deposited, and what remains looks clear and bright, especially when largely diluted. Chemical changes take place, too,—sometimes decomposition, sometimes putrefaction, sometimes simple elective combinations. If sewage contain the "germs"* of disease, whatever they may be, no agency at present known, except a sufficiently high temperature, will efficiently destroy them.† Excessive dilu-

centrated. In the memorial of the Rotherham and Kimberworth Board of Health to the English parliament, February, 1865, it is stated that the annual mortality was as great as forty in one thousand; "and the memorialists believe that the emanations from the great filth in the River Don is mainly the cause of the sickness and mortality that have prevailed, and which, to the belief of your memorialists, cannot be accounted for in any other way." The Rivers Pollution Commission attributed the great mortality from cholera in East London, in 1866, in a great degree, to the emanations from the sewage laid bare at low tide on the exposed banks of the Lea; although the contaminated water-supply was probably the chief cause.

* The word "germ" is used in this paper in its general sense, as indicating the matter which causes disease, whatever its origin, whether specific or not.

† This was the unanimous decision of the International Medical Congress at Vienna in 1874; and the same statement is made repeatedly, in various forms, by the Rivers Pollution Commissioners of England. In their last report (1875, p. 283), they say: "Slow soakage through a few feet of gravel destroys more organic matter than does a flow of many miles in the

tion simply diminishes the chances of danger from any particular tumblerful.

The most striking case illustrating this law, is one reported by Dr. E. D. Mapother, of Dublin. Forty cases of typhoid fever occurred in a hospital which received its water-supply from a river. The cause was traced to some barracks *twenty-five miles* higher up, from which typhoidal dejections had been emptied through drains into the river.

It is not known how long is the duration of life, and of the power of communicating disease in these "germs." Some authorities suppose that, like most low organisms, they perish in a comparatively short time; others think that they remain active for a long time; still others hold that certain epidemics can be explained only on the theory that the "germs" are even capable of rapid multiplication under favorable circumstances. As to what these "germs" are, we can, in the present state of science, only say, with Pettenkofer, that we "do not know." Observations* in Munich in 1866, and in Syria in 1875, have convinced Prof. von Pettenkofer that the poison [*keim*] of cholera at least may remain inactive even several months before giving rise to an outbreak; and hence the theory with certain observers, that this period of inactivity is necessary for their development into disease-producing organisms. As to the "spore-theory" of Pasteur and others, it can only be said that the *bacteria*, etc., found in the various infective diseases, whether they are different or not, cannot yet be distinguished from one another, and from those found in healthy persons. Billroth makes them all forms of one mother-plant, the *Coccobacteria septica*. Their connection with destructive decomposition of organic matter; *i. e.*, with filth, is well known. How far they are connected

Thames." The Irwell River, after leaving Manchester, runs eleven miles without further pollution of any consequence, and passes over six weirs; yet the purification is trifling. The same was found to be true of the Mersey and the Darwen.

By siphoning water from one vessel to another, so as to represent a course of ninety-six miles, experiments in England showed that the organic carbon was reduced only 6.4 per cent., and the organic nitrogen 28.4 per cent. By similar experiments, representing a flow of one hundred and ninety-two miles, the reduction was respectively 25.1 and 33.3 per cent.

* *Aerztliches Intelligenz-Blatt*, Munich, January 6, 1876.

with the *production* of disease, if at all, must be decided by future investigations.

Experience in England.

England stands at the head of the nations of the world in the matter of sanitary legislation. With a dense population confined on a narrow island, often collected near small streams, and with a law which keeps the land in the hands of a few, and crowds the laboring classes into the smallest space, a condition of filth formerly existed in many of the homes of the very poor* which we have seen only exceptionally in this country, and then in our largest cities.

In this country, the places have been, until quite recently, comparatively few where the evils of overcrowding and filth have been great. Generally speaking, we have had such an immense volume of air and water in which to dilute the filth of our towns and manufactories, that we have not been obliged to breathe and drink, in a concentrated form, the poisons whose existence has made sanitary science a necessity in England for many years. That we have fairly begun to suffer such evils, however, is becoming every day more and more apparent.

The first attempt at sanitary legislation in England, was the law of 1388, imposing fines upon those who cast filth into rivers and ditches. In 1489, slaughtering was prohibited within cities. Shakespeare's father was twice fined for violating the law concerning the removal of filth. Under Henry VIII., James I. and George II., special sanitary Acts were passed † to meet special exigencies, such as the outbreak of the plague.

In 1817–19, an epidemic of fever raged in Ireland, during which a million and a half of cases occurred, with sixty-five thousand deaths. More than one-sixth of the population of

* Compare a "Report on the Sanitary Condition of the Laboring Classes in Great Britain," by Mr. Edwin Chadwick, London, 1842; the first important contribution to sanitary literature in Great Britain, and one which did incalculable good in directing public attention to the evils of the conditions under which the masses were living. Mr. Chadwick computed that the "annual slaughter" in England, from typhus fever, a preventable disease, was greater than the loss sustained by the allied armies at the Battle of Waterloo.

† The Law Magazine and Review, London, November, 1875.

Dublin was treated in the hospitals alone; and, under the stimulus of such a pest, an Act was passed, in 1818,* authorizing the appointment of boards of health, and giving them great power.

The outbreaks of the cholera in 1831, 1849, 1854 and 1866,† hastened legislation so much, that Acts were passed one upon the top of another so rapidly, that the greatest confusion existed for many years; and even skilled lawyers found difficulty in ascertaining what was the law. The administration was naturally very defective. To consider means for consolidating all these Acts into one, the Royal Sanitary Commission was appointed in 1869, and the Public Health Act, of 1875, was the result of their labors. The commissioners say, in their first report: "Sanitary legislation has been remarkably drawn out by, and connected with, these outbreaks of cholera, which led to investigations of the means of preventing infectious diseases, and so drew attention to the fact that *the seats of endemic diseases are generally where the air or water is polluted.*" That is to say, the whole general sanitary legislation of England, for thirty years, has been chiefly directed to the removal of filth. Under these circumstances, the importance of the part played by filth, in producing disease, may, perhaps, be overrated in that country, and the part played by other causes, underrated.

The report of Mr. Chadwick, made by him as secretary of the Poor Law Board, in 1842, has been already referred to as the first public contribution to the cause of improved sanitary legislation; although Dr. Rumsey and others had done much privately, and the government had prepared the way for such investigations, and had directed attention to the prevention of disease, by the facts collected under the Act for the registration of births and deaths, passed in 1836.‡

In 1843, Mr. Chadwick published his supplementary report

* Furlong on Sanitary Legislation.

† If the Acts requiring water-companies to go higher up the river for their supplies, to furnish water uncontaminated by London sewage, and to filter it, had been passed before the cholera raged, in 1849, there can be no reasonable doubt that at least five thousand lives would have been saved, in that and the succeeding epidemics.

‡ The provisions of this Act were extended to Scotland in 1854, and to Ireland in 1864.

on the evil effects of intramural interments, and in the same year the Health of Towns Commission was appointed, under the Duke of Buccleuch as chairman. Their two exhaustive reports on the state of large towns and populous districts, and on the remedial measures which should be adopted, brought to light such a mass of evidence as to the bad sanitary condition of many of the towns in England, that the way was opened for the Public Health Act of 1848, and for the appointment of the General Board of Health. In 1847 and 1848, the Metropolitan Sanitary Commission published their three full reports. The four reports of the General Board of Health, in 1852 and 1854, contain a mass of information in regard to the sanitary state of England, especially on the subjects of sewerage and the disposal of sewage.

The three reports of the Sewage of Towns Commission; the two reports of the Select Committee on Sewage of Towns; the report of the Metropolitan Drainage Commission; the two reports of the Royal Sanitary Commission; the annual reports of the Registrar-General, and of the Medical Officer of the Privy Council; the yearly reports of the Local Government Board, and the nine reports of the two Rivers Pollution Commissions, together with those reports already named, have made the sanitary literature of England most complete and exhaustive.*

* This is not the place for a review of this valuable mass of information; but it is thought that it may be interesting briefly to mention the prominent features of the legislation that has made England the first of the nations in sanitary science.

The following list of the most important sanitary Acts will indicate how much has been done by Great Britain in this matter. The exact titles are not given in all cases:—

An Act to amend the Laws relating to Sewers, 1833.
An Act to amend the last-named Act, 1841.
Public Health Act, 1848.
An Act for further amending the Laws relating to Sewers, 1849.
An Act investing Local Boards of Health with certain powers, 1849.
An Act to amend the Public Health Act, 1851.
An Act to amend the Public Health Act, 1852.
An Act relating to Repayment of Loans under the Public Health Act, 1853.
An Act reappointing the General Board of Health, 1854.
An Act continuing in office the General Board of Health, 1855.
Diseases Prevention Act, 1855.
Nuisances Removal Act, 1855.

In 1848 the "Public Health Act" was passed, and, to secure its administration, the General Board of Health was appointed, to serve six years. The board was reconstructed in 1854; and in 1858, at the expiration of their term of service, their powers passed into the hands of the newly-appointed medical officer of the privy council, who is virtually a health minister of the English government. The "Local Government Act," to be construed in connection with the Public Health Act of 1848, was passed in the same year. In 1866 the "Sanitary Act" was passed. At the close of the session of 1872, a second "Public Health Act" was hurried through.

An Act transferring duties, etc., of the General Board of Health to the Privy Council, and appointing a medical officer of the Privy Council, 1858.
Local Government Act to amend the Public Health Act, 1858.
Nuisances Removal Amendment Act, 1860.
Local Government Amendment Act, 1861.
Drainage of Land Act, 1861.
Local Government Amendment Act, 1863.
Nuisances Removal Amendment Act, 1863.
The Metropolis Sewage and Essex Reclamation Act, 1865.
Sewage Utilization Act, 1865.
Nuisances Removal Amendment Act, 1866.
Metropolitan Sewage and Essex Reclamation Act, 1866.
The Sanitary Act, 1867.
Sanitary Amendment Act, 1868.
An Act authorizing Loans for Sanitary Purposes, 1869.
Sewage Utilization Act, 1870.
Hornsey Sewage Act, 1871.
Public Health Act, 1872, dividing England into urban and rural sanitary districts.
Public Health Act, 1875.

There have also been many Acts passed from time to time, with reference to special localities, and also on special subjects. Among them are the following:—

On Adulteration of Food,	3	On Metropolis Management,	3
Alkali Works,	2	Metropolis Water,	2
Artisans' and Laborers' Dwellings,	3	Quarantine,	1
Baths and Wash-houses,	3	Registration of Deaths,	2
Burials,	9	Smoke Nuisance,	2
Cemeteries,	1	Thames Conservancy and Navigations (Pollution),	3
Common Lodging-houses,	2	Towns Improvement,	4
Contagious Diseases,	2	Vaccination,	2
Laborers' Lodging-houses,	1	Workshops Regulations,	4
Main Drainage (London),	4		

Beside those reports already mentioned, England has published over two hundred others on sanitary subjects, chiefly the results of special investigations.

This has been subjected to a great deal of adverse criticism, but it contains one important provision that it is worth while to notice. The Local Government Board had been formed in 1871, and by the new Act it became the central bureau, under which every sanitary authority was *obliged* * to appoint a medical officer of health, who might be also the medical officer of the union in rural districts. As a result of this provision, no place in England or Wales is now without a sanitary officer; but they are often miserably underpaid, and elected by the local authorities of their own towns. They are, therefore, sometimes too much governed by local influences to be independent, efficient health officers; as they always must be in all countries under such conditions.†

The great objection to the Public Health Act of 1872 was that it was entirely permissive in its character as to the duties of health officers, and that something of a compulsory nature was needed. A step in such legislation has, however, been made in the "Artisans and Laborers' Dwelling Act," 1875, by which local authorities are not only allowed to tear down buildings unfit for use as dwellings, and to sell the land if the owner refuses to place proper buildings thereon, but under certain circumstances they can be compelled to do so by the central authority.

Finally, the "Public Health Act," 1875, consolidates twenty sanitary Acts into a single one of three hundred and forty-three sections, and makes the local officers of health responsible to the central government. Three commentaries on this Act have already appeared, edited by able lawyers.

The Sewage-Question in England.

Sewers have existed in England since the time of the Romans; but the first attempt at a sewerage system was made in London directly after the great fire of 1666. The old sewers had been badly constructed, and the introduction of the water-closet, about the beginning of the present century, only served to render still worse a soil which had already been seriously contaminated by soakage of fecal matters. The

* The "Contagious Diseases Act" *authorized* such appointments.

† See the Fifth Annual Report of the State Board of Health of Massachusetts under "Health of Towns," pp. 514 and 515.

evil became so great that, in London, an Act was passed forbidding the connection of water-closets with sewers; and cesspools came into use all over the city, contaminating the wells in all directions.

About 1815 an Act of parliament *allowed* water-closets* to be discharged into the sewers, and in 1847 another Act was passed *requiring* all cesspools and privies to be abolished, and the sewers to be used in their stead. It would be difficult to imagine the condition of filth then existing, as shown by Mr. Chadwick's report and those of the Health of Towns Commission. Open vaults, exposed to sun and rain, were often used for several contiguous houses. Cesspools and privies were made in cellars, and covered with dirt when full; and sewers, where they had been built at all, were too often simply badly-constructed receptacles for retaining filth, instead of discharging it.

The "Public Health Act," 1848, gave local authorities power to build sewers and discharge them into streams, wherever they saw fit. Then began, on a large scale, the pollution of the rivers of the country, which has since become so great an evil; for, by section xlix. of the same Act, all private dwellings, whether built before or after the passage of the Act, were required to have properly-constructed drains connected with the public sewers, provided there were any such within a distance of one hundred feet.

* Before 1847, the sewers of London were managed by eight separate corporations. To remedy the evils arising from this divided administration, and to devise a scheme for the permanent relief of the city, six commissions were at different times appointed; and finally, in 1856, the Metropolitan Board of Works was established, with full control of the matter. This board, after considering the various plans suggested, adopted that of Messrs. Hayward and Bazalgette for a system of intercepting sewers, high level, middle level and low level, with four pumping-stations, Thames embankment, and outlets respectively ten and fourteen miles below the city.

A great part of the session of Parliament of 1853 had been occupied in considering the scheme of "The Great London Drainage Company," composed of a number of private individuals, who guaranteed a large sum for carrying the sewage far below London, extracting its "valuable constituents," and selling them for manure. The company was to start with a capital of one million pounds, and assumed that there would be a great profit. Their plans were considered visionary, and were not adopted.

The metropolis, as defined by Act of parliament, covers an area of 117 square miles. [Report to the Metropolitan Board of Works by Messrs. Bidder, Hawksley and Bazalgette, London, 1858.]

By the "Nuisances Removal Act," 1855, provision was first made for enjoining individuals, towns and corporations against the pollution of streams. To provide for the full carrying-out of the requirements of the Act, section ix. contains a clause that "the local authorities *shall*" appoint or employ a sanitary inspector or inspectors. In 1858, the "Local Government Act" empowered local boards to make arrangements for the sale of sewage, or for its distribution over the land. Local authorities, too, were rendered liable to injunction for polluting streams.

At this time the rivers of England had, many of them, become so foul that a few towns had been forced into experimental works for precipitating the sewage, or utilizing it upon the land.* In 1860, the Sewage of Towns Commission, in their second report, said that the matter had become an "evil of national urgency, requiring the earliest and most serious attention, with a view to the application of remedial measures." . . .

"The Irwell, the Irk, and the Medlock, at Manchester, have long been notorious for offensiveness, both to sense of sight and smell." . . . "The bright stream above Middleton is made black and repulsive immediately below the town." . . . "The bright water of the Bradshaw Brook and reservoir soon become the color of ink." . . . "The discharge from some of the large towns [on the Rock] must, in the summer time, become a very dangerous nuisance." . . . "The water of the Mersey has become a black, offensive liquid." . . . "No description can give an idea of the fluid of the Medlock . . . At the time of our visit, a black, thick, noisome scum covered the surface of the river and canal, and bubbles of gas constantly burst up from below; although the weather was very cold. In summer this scum on the surface is said to be much extended, and at times of such consistency that birds walk over it. The stench is described as scarcely endurable."

With very few exceptions, the streams of the West Riding of Yorkshire ran with a liquid which had more the appearance of ink than of water. The Bradford Canal was so pol-

* One hundred and sixteen schemes were presented to the different commissions for purifying the Thames alone.

luted as to give off large quantities of inflammable gas, to which the boys used to set fire for amusement; the flames would sometimes reach six feet high, and run along the surface of the canal for many yards.*

Previous to the adoption of the Local Government Act, the Irwell River and the Greave and Clough brooks were so choked that in certain instances archways of bridges were blocked, sufficient room not being left for the storm-water, and parts of the neighboring town were consequently flooded. In 1870, the exceedingly offensive smell of one stream could be perceived at a distance of from one to two miles from its banks. . . . "It is no exaggeration to say that this brook renders the country, within two miles of its banks, uninhabitable, except under a penalty of so much discomfort as few would be prevailed upon to endure."† Another stream was so acidified by refuse from alkali-works, that iron boats could not be used in it. A gentleman wrote a letter to the Second Rivers Pollution Commission, using water from the Calder River instead of ink.

Even before public attention had been drawn so pointedly to such facts as these, it had happened that the first case of cholera in one of the epidemics occurred in a ship from a foreign port, anchored opposite the mouth of a sewer opening into the Thames. A war against sewers and water-closets began, and they were accused of causing diphtheria, typhoid fever, and almost every other disease, as if no other cause existed. Typhoid fever, especially, was said to be increased by the introduction of water-closets. It is a noteworthy fact, however, that many of the strongest opponents of the water-carriage system insisted on having water-closets in their own houses, and on using the sewers, which had by this time become necessities.

Undoubtedly bad ventilation, bad domestic arrangements, defective plumbing and polluted drinking-water from intermittent supplies, have given rise to a considerable amount of disease, and this has generally appeared about three years after the completion of works of water-supply and drainage,

* Third Report of the First Rivers Pollution Commission.

† First Report of the Second Rivers Pollution Commission.

because it requires about that time, under bad management, for filth to accumulate, and for the poison in the air and water to become sufficiently concentrated to cause illness. Hence has arisen the extraordinary statement that water-supplies and complete sewerage lower death-rates for three years, and then increase them.*

It has been claimed that the increase of diarrhœal diseases in England is due to the adoption of the water-carriage system; but a careful examination of the returns of the registrar-general shows the fact that, with the constantly-increasing density of population, such diseases have increased in Lancashire, where the old system of removing excrement by hand is still largely adhered to, but that they have remained stationary or decreased where water-closets have been largely introduced, the less favorable condition in the former case overbalancing the improvement in the latter.†

In Croydon, according to the high authority of Dr. Alfred Carpenter, typhoid fever has become a disease of the suburban part of the city, where there are no sewers. There have been two severe epidemics of typhoid fever in that city since the sewers were constructed. The first, twenty years ago, arose from pollution of the air, and was abated by the adoption of efficient sewer-ventilation. The second epidemic, that of 1875, has been already traced to an intermittent water-supply, polluted by sewage-emanations. Dr. Carpenter did not hesitate to predict this epidemic years ago, but the security of a few summers led the authorities to believe that there was no evil to remedy, and no remedy was applied.

* In Glasgow and Edinburgh, typhoid fever in the houses of the better class on high land is generally attributed to sewer-gases; but the sewers in these two cities are badly ventilated, and the water-closets are often adapted to old houses, and without any ventilation at all, in the proper sense of the word. In the poorer parts of these cities, where there are few water-closets, typhoid is rare, and typhus fever is common. One is inclined to think that the more virulent poison produces the severer disease (typhus), to the exclusion of the milder one (typhoid).

† The fact should not be overlooked that the high rates of mortality in Lancashire are probably, in a considerable measure, due to the character and condition of the laboring classes, and especially to the fact that women are so much employed in the factories that many of them are unable to nurse their children.

The known factors of the disease had been present for many years, and when the unknown factor was added, an alarming amount of disease and death was the result.*

Experience has fully shown that the dangers to health are least under the water-carriage system, if properly managed; and the common-sense of the community has declared it the most decent and the most convenient. In the report already quoted, the Sewage of Towns Commission say: "If one of two evils were unavoidable, it would be better that the rivers should be polluted than that the atmosphere in which we live should be subject to constant deterioration; but this is not really the question. Both evils may be avoided. But it is strikingly shown in this district [Lancashire] that, notwithstanding the purity of the air of the town is sacrificed by a retention of its fecal matter, the rivers are at the same time so polluted by the discharge of town-refuse of various kinds as to call imperatively for remedial measures."

In 1865, the idea had become quite prevalent that large fortunes were to be made both from the precipitated manure of sewage and by utilizing it on irrigation-farms, in spite of repeated statements of authoritative bodies to the contrary. The Metropolitan Sewage and Essex Reclamation Company was incorporated by special Act of parliament to raise a capital of over two million pounds to reclaim from the sea the enormous flats at the mouth of the Thames, and to utilize the sewage upon them. The enterprise failed.

In the next year, the advent of the cholera gave a new stimulus to the question, from the fact that the soil and wells were found to be so universally polluted by cesspools, etc. No distance from cesspool† to well that was practicable in a city was found to be safe. Eassie‡ found that in one place

* In September, 1875, the disease had entirely disappeared. On the 16th of that month the authorities gave another intermittent supply over a part of the district, and over that part typhoid fever again became prevalent. It subsided, and "the local board will not again make such a serious mistake."

† In England, at the present time, the slow poison from sewers, cesspools, half-buried and forgotten privies, &c., produces so characteristic a type in disease, that expert physicians do not fail to recognize it; and many unsuspected cesspools and leaky drains have in this way been unearthed.

‡ Sanitary Record, October 23, 1875.

cesspool-filth permeated through the soil for a distance of two hundred yards, and poisoned wells.*

According to Dr. Letheby, very many of such polluted wells in London "yielded cool, bright and clear waters." Other analysts say that they are "commonly clear." An official return in 1872 gives a list of polluted wells in the metropolis of London; and the Rivers Pollution Commission, in their sixth report (pp. 85 and 283), say that the samples from these wells consisted chiefly or entirely of the soakage from sewers and cesspools, and that some of them actually had a manure-value one hundred and fifty per cent. greater than that of average London sewage. One or two had a slight saline taste, piquant to some water-drinkers; but most of them were bright and palatable, and the pumps yielding them enjoyed, for the most part, a high reputation.†

In one epidemic of cholera, the water of the Broad Street pump, which enjoyed a wide reputation as a pleasant, sparkling beverage, although "horribly polluted" by a neighboring cesspool, is estimated to have caused 609 deaths. The Duke Street pump, in Dublin, had a similar history.

In the Sewage Utilization Act of 1865, we find this clause: "Nothing contained in this Act or any other Acts referred to therein (*i. e.*, all the sanitary Acts previously passed), shall authorize any sewer-authority to make a sewer so as to drain direct into any stream or water-course." By the same Acts, the powers of sewer authorities were extended as to the pollution of streams. Seventeen years had sufficed to reverse entirely the laws on the subject. In 1848, towns were urged to empty sewage freely into the most convenient water-courses.

* In France, attention was directed to this matter over forty years ago, and especially with regard to the pollution of wells from cemeteries. A law was passed prohibiting the opening of wells within one hundred meters[1] of any place of burial; but that distance was soon found insufficient for deep wells, which have larger drainage-areas than those near the surface, and which were found to be polluted, in some cases at a distance of two hundred meters. A well seventy-four meters deep, at Bondy, near Paris, was polluted by the contents of cesspools stored there.

† A celebrated horticulturist in Brighton, England, dilutes his manure until it has neither taste nor smell.

[1] As the metric system is used in several places in this paper, the reader is referred to the table of equivalents on page 18.

The Sewage Utilization Act of 1867 allowed authorities to purchase land, either in or out of their districts, or to lease it for seven years, for sewage-works. With the aid of all these Acts, and after many injunctions, the work of purifying the streams of England proceeded very slowly, until the Act of 1869 allowed towns to borrow of the general government money for sanitary improvements at a low rate of interest.

Even then, however, it was almost impossible for the court to enforce much vigorous action. In 1871, the Royal Sanitary Commissioners say (Second Report, vol. 2, p. 345): "These courts have proved incompetent to deal with the mischief and inefficient to stop the evil."

The latest legislation shows different results. In a recent case, "The Attorney-General *v.* the Mayor of Darlington," the defendants, who had been enjoined from polluting air and water by their sewage, petitioned to have the time for the completion of their works extended to June, 1876. The vice-chancellor held that the authorities had been dilatory, allowed them till March 1, 1876, to remove all causes of offence, and decided that they should pay the costs of the trial. The excuse that they could not get land he considered insufficient, as they might apply to parliament for a special Act to take land, if they could not get it under existing laws.

A few years ago earth-closets were accepted, by Act of parliament, as a substitute where water-closets had been required by previous laws.

There are no accurate returns of the towns which are making attempts to purify their sewage. In 1873 there were, according to a parliamentary paper, one hundred and twenty-eight that had done so by means of loans from the government alone.* As a rule, after injunctions have been served requiring towns "to purify their sewage according to the best known methods," the authorities have been apparently satisfied if any attempt is made, no matter how imperfect its results; and actual penalties have not, as yet, been inflicted on individuals, corporations or towns for polluting streams.

The Esk, and a few other streams, have been somewhat

* This is probably considerably more than half the total number. In 1868 twelve towns had adopted measures for the purification of sewage; in 1869, there were thirty.

purified from the refuse of manufactories, after repeated injunctions, and in a few cases from the fear of injunctions; but, generally speaking, there is not yet any decision reached as to whether the manufacturers themselves, or the towns within the limits of which they discharge their refuse, are to keep the rivers clean. The policy of the government has been gradually to educate the manufacturers into the knowledge that it is for their interest that the streams should be purified.

Considerable progress, however, has been made in purifying the refuse from dye-works and print-works, the alkaline refuse from the one neutralizing the acid from the other, and carrying down in the precipitate, as a mud, many of the impurities of both fluids. Solid materials, too, like ashes and cinders, are now kept out of the streams, in many cases; but manufacturers are generally obliged to have depositing reservoirs, in order to purify the water which they get for their own use, when they require to have it clean.

Several of the large cities in England get their water-supplies from sources polluted by sewage.* The stench from some of their rivers in summer is still considerable. Under such circumstances the greatest attention has been given to the subject. The first Rivers Pollution Commission was appointed in 1866, and the second in 1868. Their exhaustive investigations have extended over ten years. A Rivers Pollution bill was introduced in 1872, with the object of compelling the cleansing of the water-courses, but it has been modified many times, and has not yet been passed.

The Rivers Pollution bill of 1875 also failed to pass, but it fairly represents the mature opinion of England at the present time, and will probably be more successful at the next session of parliament. It provides that no liquid or solid sewage be passed into lakes, canals, streams or rivers, unless it be first purified by "the best practicable and available means"; that sanitary authorities provide sewers for manufacturers, the latter to pay any additional expense required for dealing with heated, filthy, noxious or polluting fluids discharged by them;

* Before a better water-supply had been furnished to Castleford and Birmingham, many of the inhabitants of those places were obliged to use the polluted waters of the Aire and the Tame for domestic purposes.

that no poisonous matters be discharged into the sewers until they be first rendered harmless; that the Local Government Board may *compel* local authorities to carry out the provisions of the Act; and, finally, that offences are to be restrained by summary order of the county court, defaulters to be fined £50 a day.

The English law does not state what are the "best practicable and available means" of purifying sewage. Undoubtedly, no universal rule can be made to apply to all cases. The impossibility of getting land in some cases, and the exorbitant rents demanded for it in others, have driven some towns to processes which did not find favor with them, but which can be carried out only on small areas.

No authoritative body,* so far as I have been able to learn, has declared itself as fully satisfied with any other process for the purification of sewage than that of irrigation.†

"Sewage-interception is always practicable. Where it can be applied fresh to the land, there is least nuisance, and least cost to the rate-payers. Where the solids are extracted by mechanical deposition, there is pecuniary loss in the operation, and running streams receiving the effluent water are still polluted, the pollution being greater as the volume in the stream is relatively small. No arrangements for treating

* Compare Mr. Chadwick's report in 1842; Mr. Austin's report in 1857; the reports of the Sewage of Towns Commission; the evidence before the select committee on the Sewage of Towns; the reports of the General Board of Health, of the Royal Sanitary Commission, of the Metropolitan Drainage Commission, of the two Rivers Pollution Commissions; and, finally, the reports of the Medical Officer of the Privy Council. In individual cases the officers of the Home Secretary have reported, after investigation, that "the best practical means of dealing with the sewage" had been used when other processes had been adopted. In these cases there was some special difficulty in the way, and a very liberal interpretation has always been given to the law.

† It has been stated by the opponents of irrigation that "parliamentary committees and royal commissions, that have been created for the express purpose of dealing with this important question, have approached the inquiry with a manifest bias in favor of some particular scheme, and with a preconceived opinion of the way in which the subject should be treated. They have, therefore, selected their witnesses and sifted the evidence so as to suit the particular objects in view." [The Sewage Question: from Dr. Letheby's "Notes and Chemical Analyses." London: 1872.] It can hardly be possible that such an opinion is at all general. It certainly would not find favor in this country.

sewage are satisfactory, except its direct application to the land for agricultural purposes."

This statement of the First Rivers Pollution Commission in 1867, may fairly be taken as the result of twenty-five years' experience in England; and the "official opinion," if the term may be used, has not changed since that time. They also recommended, "That after the lapse of a period to be allowed for the alteration of existing arrangements, it may be made unlawful for any sewage, unless the same has been passed over land so as to become purified, or for any injurious refuse from manufactures or agriculture, to be cast into the river Lea, or into any of its tributaries; and that persons offending in this respect be made liable to penalties to be recovered summarily."

The Sewage of Towns Commission (the Earl of Essex, Robert Rawlinson, J. Thomas Way and John Simon) has given the same opinion in their second report in these words: "It is matter of regret that so little progress has been made in the utilization of sewage in this way since the period of our previous report." They consider the most complete and beneficial method of disposing of sewage, where circumstances are favorable, to be its direct application to land in the liquid form. In their last report they say: "The right way to dispose of town-sewage is to apply it continuously to land; and it is only by such application that the pollution of rivers can be avoided."

Substitutes for the Water-Carriage System.

Many towns as well as individuals, with a view to avoiding the evils connected with sewers and water-closets, have adopted various substitutes, the more common of which, as used in England, will be briefly considered.

The more important of the substitutes for the water-closet system are,

1. Moule's Dry-Earth Closet.
2. The Charcoal-Closet.
3. The Goux System.
4. The Ashpit.

1. The earth-closet is tolerably familiar to us in this country; but here and in England it is universally considered inferior to the water-closet in point of c'eanliness and comfort, while scientific investigation thus far does not indicate that earth is any better as a disinfectant than water, if as good. Considering the trouble of providing sufficient earth (four pounds daily to each individual), the trouble and expense of artificially drying it, and the annoyance from frequent removal by hand of a large quantity of material which has only a trifling commercial value, the earth-closet has always given way as soon as water-closets have become obtainable. With careful supervision, however, they serve a very good purpose, and in country sick-rooms, especially if powdered charcoal be used instead of earth, are perhaps the best things attainable. Practically speaking, they do not often get attention and care enough. In New Orleans * they have become a great nuisance in the public schools. With constant care they serve an admirable purpose.

Dr. Buchanan, in a report on dry-earth closets, says, in the twelfth report of the Medical Officer of the Privy Council of England, p. 80: "If about a pound and a half of suitable earth, *carefully dried*, be thrown over a dejection, all smell from it is forthwith removed; and, if the same quantity be mixed with half a pint of urine, the latter is absorbed."

Even on this estimate, which is very low, of the amount of earth required by each individual, and assuming that four persons use one closet, every house would require, for each closet, about one ton of earth each year, making nearly 85,000 tons, or fifty acres of land about two feet deep, for a city of the size of Boston.

This earth must be dug, screened, dried, carted to the houses and removed again. The method is at least an expensive and troublesome one on a large scale.

2. The charcoal-closet is used by about twenty thousand workmen in the ship-yards on the Clyde, and in many of the public privies in Glasgow. It is open to many of the same objections as the earth-closet. If worked by automatic apparatus, it gets out of order easily. If the application of

* Report of the New Orleans Board of Health, 1875.

the absorbent is intrusted to each one after using the closet, or even to nurses and attendants, as in the fever hospital in Glasgow, this process is occasionally neglected, and a nuisance may result. The charcoal is removed and stored under cover until a considerable quantity has accumulated, when it is removed by a company who extract ammonia, etc., from it, and return it dry, free of charge, to be used again.

3. The Goux system, introduced from France, is used somewhat in a few towns in England. It consists in collecting the excrement in tubs lined with dry absorbents, such as dust, chaff, house-sweepings, etc. A feeble manure of slight value is obtained. In one of the towns in England where 3,120 of the Goux closets are in use, over a thousand tons of this manure have accumulated because, as the manager said, they will not allow the farmers to take it at one-fourth of its cost, which is all that could be got for it.

4. Ash-closets are used largely in Lancashire. In Manchester there are over 15,000 of them. The daily scavenging in that city is done at a cost of £10,000 a year, whereas all their privies, cesspools and ashpits might be abolished, and drains might be provided at a cost of only £60,000, of which the yearly interest would be £2,400 in place of the £10,000 now spent. This expensive and disagreeable method of removing the "filthy stuff, too poor for use * as manure," is adopted under the conviction that in this way their sewage may be kept inoffensive enough to be discharged into the river Irwell without purification; but the investigations of the Rivers Pollution Commission show conclusively that the sewage contains nearly as great a proportion of putrescible matter in this form as when collected by the water-closet system. The condensed table on the next page, from Hoffmann and Witt, shows this fact most clearly. The results are given in parts per 100,000.

Where, however, for any reasons, sewers are not to be had, this system of removal is very much to be preferred to cesspools, privies, etc.

* Where ashes are not largely mixed with the excrement, as at Rochdale, the sale produces quite a fair revenue.

COMPOSITION OF SEWAGE.		Average of 54 specimens from 18 cities and towns where water-closets are used.	Average of 87 specimens from 15 cities and towns where water-closets are not used.
Total of solid matters in solution,		72.200	82.400
Organic carbon,		4.696	4.181
Organic nitrogen,		2.205	1.975
Ammonia,		6.703	5.435
Nitrogen, as nitrates and nitrites,		.003	0.000
Total combined nitrogen,		7.728	6.451
Chlorine,		10.660	11.540
Suspended matter,	Mineral,	24.180	17.810
	Organic,	20.510	21.300
	Total,	44.690	39.110

The proportion of putrescible organic matter in solution was greater from sewage in the water-closet towns, but that in suspension was greater in the others. Of course, the total quantity of refuse discharged by the sewers is less in the towns supplied with privies. The amount of sewage corresponding to 1,066 persons where water-closets are used, is the same as that from 1,154 under the other system.

Experience in France.

In France, sanitary measures have formed an important part of the *Code Napoléon* since the time of the First Empire. The scientific inquiries made in Paris, and the results as embodied in legislation, at the time when the French *grandeur* was at its height, were freely quoted in England when questions relating to public health began to attract attention there.

No general systems of sewerage in populous places had, as in England, sent the sewage of millions of people into the small streams. The manufactories of France are still largely such as do not use "gross material" to the same extent as is done in England, nor do they have so large an amount of refuse to dispose of. Even in the larger cities the *fosses d'aisance*, (cesspools) and *fosses mobiles*, (pails, tubs, barrels, etc., emptied by hand) are commonly used, while still ruder

appliances are common in the small towns and villages, so that comparatively little passes into the streams.

There are five laws (of 1669, 1672, 1777, 1782 and 1783) prohibiting, under penalty of punishments and fines, the obstruction of navigable rivers by dams and mills of certain kinds. At the same time, all persons are forbidden to cast into such rivers anything which tends to raise their beds, or to throw any filth of any kind on the banks. In the case of small, non-navigable streams, local *préfets* and *maires* are allowed to make and enforce such regulations * as the health of the community demand.

We have seen that formerly similar laws were enforced in England; but the enormous development of the manufacturing industry in that country, and the national sensitiveness as to the liberty of the subject, served in course of time to render them all dead-letters.

Much has been done in France towards the utilization of the refuse from manufactures, so that the rivers Vesle, Mollette and Montford, are now much purer than they were ten years ago. This result has been partly due to voluntary coöperation with the government on the part of the manufacturers, and partly to the coercive measures of the *Conseil d'hygiène et de salubrité*. Various plans for purifying the sewage have been tested, but the results of Prof. Moll's extensive experiments show that only irrigation is successful. In regard to the refuse fluids from starch-works, he says that, "before fermentation, they are inodorous and quite harmless for vegetables. If, on the contrary, they are kept in ditches for settlement, they soon stink and destroy all vegetation."†

In spite of the cesspool-system, and the necessarily offensive methods of emptying them, the sewage proper has already seriously polluted the streams in the neighborhood of Marseilles, Lyon, Rheims and Paris. In the latter two

* The fear of the approach of the cholera, in 1848, led to a decree creating in each district of France, a council of public health to be connected with a central council of the department. These boards have not accomplished much. Different branches of sanitary affairs are now under the Minister of Agriculture and Commerce, the Minister of the Interior, and the Minister of War and of the Navy. A strong effort is making for the creation of a Minister of Hygiene and Public Health.

† Translated by Edwin Chadwick, Esq. [Journal of the Society of Arts, September 17, 1875].

cities, expensive dredging is resorted to, in order to clear the Vesle and the Seine from sewage-deposits, and the stench from the two rivers is intensely disagreeable. At Clichy, when the larger intercepting sewer of Paris discharges, the stream is dark, offensive, and bubbling with gases that result from decomposition.* Nevertheless, the banks are lined with fishermen, who have "good luck" unless they get near the sewer-outlets, where the fish are too well fed to bite.†

The places are, then, comparatively few, where the pollution of the streams has become so serious as to make their purification a matter of immediate importance; but the matter has attracted the attention of scientific investigators for twenty ,years. By a serious of experiments at the laboratory of the *École des Ponts et Chaussées* under MM. Belgrand and Léon Durand-Claye, the various precipitating processes were found to *clarify* the sewage; but the effluent fluids always contained a large part of the matters valuable as manure. No opinion was given in their report as to the value of the solid residue as manure. The laboratory experiments seemed rather favorable to precipitation, for no account was taken of the difficulty of getting rid of the precipitate, and the effluent was found valuable for irrigation.‡ One hundred thousand francs were, therefore, voted to M. Mille, who had already investigated and written upon the subject, and to M. Alfred Durand-Claye, to carry on experiments on a large scale at Clichy. A few acres of land were taken; irrigation was successful, but precipitation was only tolerably so. It was found that in practice the precipitation-processes were clumsy, offensive, costly and inefficient, that they *clarified* without *purifying*. Moreover, if the precipitate were carried more than a few miles, its value was found to be not sufficient to pay for cartage. The report was decidedly in favor of irrigation.

In 1849, it cost 9,000 francs to dredge sewage from the Seine. In 1869, the sum had increased to 100,000 francs. The river was rather sluggish, and complaints of offensive

* There are no extensive flats near Paris, as there are near London; and, there being no ebb tide to return the filth from the sewers, it is carried down to pollute the air and drinking-water of towns nearer the sea.

† It is *putrid* sewage or the refuse from certain manufactories which drives fish from the rivers.

‡ "Elles seraient très-favorables pour l'irrigation."

odors from it kept increasing. Finally, in 1868, 800,000 francs were appropriated for the works at Gennevilliers, a peninsula formed by a bend of the Seine opposite Paris. Two steam-pumps were located at Asnières, and iron conduits were built across the Seine to convey the sewage to the gravelly plain which it was proposed to irrigate. The city took a farm of twelve acres; and the result of the first year's cultivation by sewage was so astonishing that in the next July "farmers applied for twenty-four acres more; in August, for forty; and in September for sixty."* The profits of the farmers were great; for the soil was sandy and barren, and the sewage, which cost the city a large sum for its delivery, was given them for nothing. The experiment is still going on, although it was interrupted for a time by the war.†

In 1870 an official provisional injunction ("*sorte d'injonction*") from the state increased the zeal of the city to purify the river, and renewed efforts were made to extend the area of irrigation. Six thousand cubic meters of sewage were used daily on eighty acres. A plan was approved which was to cost 10,000,000 francs; but the war broke out, and all operations were suspended. In 1872, a million francs were voted, and the work is continually extending.

As early as 1848, the increase of the woolen factories at Rheims had drawn attention to the great pollution of the river Vesle. Two intercepting sewers were built in 1852, conveying the sewage to precipitating-tanks, where it was clarified by simple subsidence. The process was kept up for five years, and was then abandoned because the precipitate met with scarcely any favor as a manure; "the pollution of the river continued," and the complaints against the city increased. The mayor appointed a commission, with Duchâteau at the head, who made an exhaustive report on the subject in 1870, after making many experiments with sewage on a small scale. Their experience was derived from England, and they decided to try the two methods (irrigation and precipitation) in use

* One hundred and eighty acres were cultivated in 1874, and about the same number in 1875; forty thousand cubic meters of sewage being delivered on the farm daily, of which a considerable quantity was wasted.

† The bridge carrying the main conduits was blown up. Later it was the scene of an engagement between the Commune and the army of Versailles.

there. The river had become extremely filthy. Its greatest flow was eight cubic meters a second, and in summer only six hundred or even two hundred decimeters. It received nineteen thousand cubic meters of sewage daily, or three hundred to each one thousand inhabitants.* The river contained, in itself, only twice as much water as there was sewage flowing into it. The daily discharge of sewage contained thirty thousand kilograms of impurities in suspension and in solution.

The "lime process" was tried and found inefficient, because, although it precipitated the solids, its action on the soluble organic matter, like that of all other chemical processes, was almost nothing. The ammonia was set free by the stronger alkali, and lost; so that people complained of the bad smell from the works as much as ever before.

Similar practical difficulties were encountered in testing the other precipitating processes, and none gave results "worthy the attention of the commission," except a mixture of lime with a ferruginous clay and sulphate of iron. The manure produced cost 176,000 francs a year, or eight francs a ton, including transportation of six miles. It could be sold only at great loss, as each ton (nine hundred kilograms,) contained two hundred kilograms of worthless mineral matter, and three hundred and fifty to seven hundred kilograms of water. To obtain an idea of its value as compared with common manure, which was much cheaper, three lots of land of equal size, were cultivated for two years, with the following results in crops raised during the two seasons:—

CROPS RAISED.	Lot 1—With stable-manure, weight in kilograms.	Lot 2—With sewage-precipitate, weight in kilograms.	Lot 3—Without any fertilizer, weight in kilograms.
First year, beets, ...	44,400	37,200	25,000
Second year, wheat, Straw, . .	6,080	4,900	2,740
Second year, wheat, Grain, . .	1,860	1,540	1,175

* In Paris the proportion is only one-half as great.

Fifty cubic meters were used upon each acre. Irrigation was decided to be the least expensive, and the only satisfactory method, and has been adopted.*

The sewage of Versailles and of St. Germain will probably be utilized, as complaints are loud in regard to the condition of the streams into which they drain. Imperfect irrigation is carried on at Carcassonne, Cambrai, Aix and Chambery. Many of the manufacturers in the north of France partially purify their sewage, or irrigate with it.

The precipitating processes are not used by cities or towns.

Experience in Germany.

There are no general laws in Germany for the supervision of factories, nor any laws forbidding the discharge of sewage into water-courses. The Act of 1843, of Prussia, prohibits manufacturers from casting into streams water which had been used for dyeing, fulling, tanning, and similar processes, if annoyance be caused thereby to the public, or their supply of pure water endangered. The law of 1846, of the same country, requires owners of works to remove from the sewage any ingredients injurious to the culture of any meadow-lands over which they may flow. The interpretation and enforcement of these two Acts rest with the police of the various cities and towns.

Until ten years ago, Hamburg was the only German city which had a sewerage-system, and water-closets in a large number of its houses. The other cities were all more or less filthy. Throughout the Empire, the use of cesspools and tubs was universal. Varrentrapp stated, in 1868, that it was offensive, to both eyes and nose, to enter the majority of German houses in the warm weather. The few sewers which existed were, many of them, so choked with filth, that it was often difficult to ascertain even of what their bottoms were made. In spite of all this, some of the rivers were very filthy, although none of them, except the Spree and a few others, had approached the condition of some of the English rivers.

* Rapport sur les Eaux d'Égout de Reims par M. Alfred Durand-Claye, ingénieur des ponts et chaussées. [Bulletin Mensuel de la Société des Agriculteurs de France, 1er Juillet, 1873.]

Berlin, a city now of nearly a million inhabitants, in 1861 had only 1,584 houses supplied with water-closets, and the number was not quite trebled in the next four years. The city was so badly drained, that the authorities had been at work, since 1828, trying to devise means for improving it. Various projects were proposed; but some were too costly, and others were insufficient.

Scientific men, with Pettenkofer at their head, opposed sewers, because the only ones with which they were familiar were badly constructed, allowing the sewage to escape freely, and to contaminate the soil. This was considered an evil to be avoided at any cost, in view of the theory that typhoid fever and cholera were directly dependent on low levels of ground-water, and organic decomposition going on there. By digging down to the sides of badly-constructed sewers, Pettenkofer found the soil moist and foul-smelling; and Feichtinger found large quantities of organic matter in such soil. In his report on the sewerage of Basel, in 1869, Pettenkofer opposed the introduction of water-closets.* Even granting that sewers were necessary, he thought that by keeping out of them the contents of water-closets, just so much more sewage could be kept from getting through into the soil. To his surprise, however, he found that in Rugby, with water-closets, a liter of sewage contained 151 milligrams of organic matter, while in Munich, without water-closets, it contained much more; namely, 189 milligrams. It appeared, too, that although it was forbidden by law to empty privies, etc., into the sewers, it was done so much, under cover of darkness, that night-sewage contained 37 per cent. more of soluble organic matter than that of the day-time. The chlorine and potash, especially, were increased.

In 1868, Varrentrapp published his exhaustive treatise on the drainage and sewerage of cities, completely refuting the theory that sewers must pollute the soil, and showing that

* Sewers, he said, are as bad as cesspools for contaminating the air and soil, and the cesspool-system, well ventilated, is as efficient as sewers in maintaining the purity of the air, ground, and water near houses. (*Luft, Boden und Wasser des Hauses ebenso rein zu erhalten mag wie das Schwemmsystem.*) Lindley, the distinguished engineer of the works at Hamburg and Frankfort, says that cesspools cannot be made to remain absolutely water-tight, a statement which experience has confirmed in Paris.

twenty-five years had failed to produce any such effect in Hamburg, an observation which was afterwards verified by Virchow and Pettenkofer. Varrentrapp argued that, on purely sanitary grounds, filth should be speedily and thoroughly removed, and that such an end could be accomplished only by water-closets. His practical statements were found so convincing, that the cities of Germany are fast adopting the methods which have proved so successful at Hamburg. The inland cities, generally speaking, are preparing to dispose of their sewage by irrigation, either at once, or when the increasing pollution of the rivers may demand it.

At Dantzic, the English example has been followed, by the advice of the distinguished engineer, Wiebe; and irrigation has been adopted, after some successful experiments in sewage-farming, at one of the orphan asylums.

In Munich, Pettenkofer has continued his researches on the pollution of the soil, and has finally shown, as already proved by Lindley, that well-built sewers do not allow soluble organic matter to escape into the ground to any serious extent, although they act as drains in relieving the soil of its moisture.

Dr. Wolfhügel has also proved this fact, by careful analysis of the soil in different places, as is shown in the following table: —

Table showing the comparative pollution of the soil from sewers, cesspools, and privy-vaults, as given by Dr. Med. Gustav Wolfhügel.

[Results expressed in kilograms to the cubic meter of earth.]

COMPOSITION OF EARTH.		Normal earth.	Average of earth under eight sewers.	Average of earth under eight cesspools.	Earth 4 1-2 meters from a privy-vault.
Depth in meters at which analyses were made,		3.7	*	2.4†	2.3
Soluble constituents,	Residue on evaporation,	.211	.217	.603	4.710
	Loss on ignition,	.052	.091	.185	1.500
	Organic substances,	.118	.093	1.257	2.230
	Chlorine,	.010	.021	.110	.330
	Nitric acid,	.012	.018	.019	.460
Insoluble,	Loss on ignition,	1.504	3.356	5.461	39.772
	Nitrogen,	.014	.055	.060	.956

* Directly under the sewers. † Directly under the cesspools.

By digging underneath well-built sewers, Dr. Wolfhügel showed experimentally to a large number of experts that the soil was not appreciably affected by the sewage.

In Berlin, a scientific commission was appointed in 1862, and made exhaustive experiments, continued through many years. They proved by scientific analysis and by induction, what had long before been learned in England by practical experience:—

1. That with cesspools and privies, the soil and well water become dangerously polluted.

2. That sewers need not pollute the soil.

3. That streams become so foul when used as receptacles for sewage, that measures must be taken for their purification.

4. That the only practicable means of purifying sewage is by irrigation.

They have, therefore, adopted a sewerage-system which is to be completed in 1883, and which provides for purification of the sewage by irrigation.

The Berlin commission experimented with many deodorizers,* all of which failed to prove efficient at reasonable cost. Of the precipitating systems, they tried, during several years, Suvern's (lime, tar, and chloride of magnesium) and Lenk's (alumina, soda, and chloride of zinc or iron) as promising the best of them all. They say of both that more than one-half of the soluble organic matter passed off with the effluent; that the living organisms, *bacteria*, etc., were not killed, and that the effluent was unfit to run into rivers. Of Suvern's process, they say that the "manure" produced was not of sufficient value to pay for cartage and labor;† while by Lenk's system a precipitate was formed which was worth less still, land manured with it producing smaller crops to the acre than unmanured land. Both processes clarified the sewage, the latter less quickly and completely.

* As was done by the French experimenters also; the latter selected only three, which were thought to show a reasonable prospect of success.

† In their general report they say that its value was "gleich null,"—"absolutely nothing."

EXPERIENCE IN HOLLAND.

The Netherlands, as is well known, are reclaimed from the sea, being surrounded and protected by enormous dikes, upon which the country depends for security against inundations. The level of the canals in Amsterdam is thirty centimeters below half-tide mark. Many of the cultivated fields throughout the country are covered with water during the winter months, and are kept dry in the summer by means of wind-pumps, which raise the contents of the ditches at the sides of the fields to canals, conducting them finally to the sea.

It is easy to see that the difficulties of drainage and sewerage are great, and that an abundant supply of pure water for domestic purposes is almost an impossibility. Many of the houses in the cities have common privies, discharging by straight, or nearly straight, tubes into the canals. Among the wealthy class there are a few water-closets and cesspools. The very poor have no accommodations whatever, and throw into the stagnant canals the refuse which does not escape by surface-drainage, or into the sewers at the street-openings. In Amsterdam, the canals comprise about one-fifth of the area of the city, forming ninety islands connected by nearly three hundred bridges.

Under such circumstances, the government, finding that there were so many objections to all other systems of sewerage, decided to give to the pneumatic system a fair trial. Schmick had proposed such a method for Frankfort, and other similar systems had been used to a small extent in a few of the cities of Europe.* Capt. Liernur alone, however, has brought it to any degree of perfection, and he states that it is found completed, according to his plans, only in Holland.† Plans were accepted for Leyden in 1870, and for

* It is said that Capt. Liernur got his idea from the rude pneumatic system in use at Milan, where a vacuum is got by first filling the tanks with water and then exhausting them. The water is carted about in ox-carts.

† It was first introduced into Prague in 1868, for some military barracks; later, into an insane asylum at Hanau. In answer to the statement of the Berlin Commission that in these two places the system had proved offensive, and so unsatisfactory as not to be extended, Capt. Liernur stated that the first attempts had been improved upon, and that in Holland he had overcome the difficulties which had proved so troublesome at Prague and Hanau. A commission at the Hague recommended Liernur's system for that city in

Amsterdam a few months later. The works were completed in 1871.

In Leyden, a city of 40,000 inhabitants, 1,200 people in the poorest quarter have their houses furnished with Liernur's system. That it is very much better than the previous arrangement of throwing filth into the canals by hand, is universally agreed. The authorities, however, as in Prague, apparently do not consider that the gain is in proportion to the great expense incurred, for no extension of the scheme has been agreed upon.

In Amsterdam, the odors from the canals have been for years extremely offensive.* They are all open sewers, with no current, and foul gases are constantly bubbling up during the summer. During winter the offence is less, and arises chiefly from the distribution of so much filth upon the ice. Naturally, the authorities were willing to try any system which promised any solution of their difficulty. They adopted the Liernur system in one of the poorest quarters of the city in 1870. On the 10th of April, 1872, Mayor den Tex and the aldermen decided upon its compulsory adoption in seven other small districts. At the present time, it has been introduced for a population of 6,000, or one-fiftieth of the whole city. Mayor den Tex, and the present Master of Public Works, state that it has given entire satisfaction in the poorer parts of the city, where there was absolutely no accommodation before, and where the closets connected with it are out of doors. They state, also, that its first cost renders it doubtful whether it will be extended

1867, but it has never been introduced there. It has had a similar fate lately in Rotterdam. In St. Petersburg, Capt. Liernur is making an experimental introduction of his method, with the understanding that the city is not to bear any of the expense, and that no extension is to be made unless the system proves satisfactory. Capt. Liernur is preparing plans which he hopes may be accepted for Geta and Naples. He has an agent in London, but none of the cities or towns of England have accepted the system. It has not met with approval in that country.

* The deposits in these canals, which are about four feet deep, are dredged out twice a year, and sold for a small price as manure; otherwise, navigation would be very much impeded. Since the completion of the great North Sea Canal, the canals of the city have been flooded every night by opening the gates and allowing the water to flow through from the North Sea to the branch of the Zuider-Zee, on which the city is situated.

even there; and that among the better classes the system is considered inferior to water-closets and cesspools.

*Description of the System.**

The following description is taken from a pamphlet published by Mr. Scott:—†

"In a building, in any convenient part of the town, is placed a steam-engine, which drives an air-pump, so as to maintain about three-fourths vacuum in certain cast-iron hermetically-closed reservoirs sunk below the floor.

"From these reservoirs central pipes radiate in all directions, following the main streets. On these central pipes are laid, from distance to distance, street reservoirs sunk below the pavement.

"From the street reservoirs, up and down the street, are main pipes, communicating by short branch pipes with the closets of each house.

"All the junctions of pipes with reservoirs are furnished with cocks so that they can be shut off or turned on at pleasure, like water-mains, and are got at by cock-boxes, and turned by keys in the ordinary way.

"The vacuum created in the central building reservoirs can thus be communicated to any given street reservoir, so as to furnish the motive-power by which, when the connections with the houses are opened, all the closets are simultaneously emptied.

"When their contents reach the central reservoir, they are in like manner forced through the central tubes to the reservoirs under the central building, and thence transferred by means of vacuum-power to hermetically-closed tanks above the floor of the building. From these retorts the matter is decanted in a fluid form in barrels, for immediate transport to the country, by means of hermetically-closed apparatus.

"During the construction of this system, and before connections are made with the central building, a locomotive engine empties the different street reservoirs, and the closets connected therewith, by means of a hose from the tender to the reservoir.

* For full description see Die pneumatische Canalisation in der Praxis von Capitain Liernur, Frankfurt, A. M., 1870; also articles by Mr. Adam Scott, C. E., Capt. Liernur's agent in London, in the Sanitary Record, Nov. 21, 1874; Public Health, Oct. 16, Nov. 2, and Dec. 16, 1874; the Journal of the Society of Arts, vol. xxiii., London, 1875; also various papers in the Deutsche Vierteljahrschrift für öffentliche Gesundheitspflege, and the Correspondenz-Blatt des Niederrheineschen Vereins für öffentliche Gesundheitspflege.

† Brief Description of Liernur's Pneumatic Sewerage-System. London.

"Closets of the simplest possible character are all that are required, and no water whatever is needed. The funnel is made double, the space between the two communicating by a pipe with the outside air.

"The excrement falls into a sort of hydraulic trap, capable of holding the fecal products of but one person, and compelling thus what it held before to fall into a larger trap of four times greater capacity. This latter discharges in the branch tube which is connected with the main tube, and empties into the street reservoir.

"The branch tubes from the houses are laid with a succession of grades, not less than one in ten, rising at every twenty feet by a short siphon-tube, two feet high, to the beginning of a new grade, until it falls into the main tube. It is by means of these continually repeated short bends that the removal of the contents of so many privies, by turning only one cock on a main pipe, is possible, whether or not any are empty on account of the house being uninhabited. The fecal mass itself practically forms the required temporary closure from the main pipe, allowing through its inertia all the branch pipes to be simultaneously and equally acted upon under all circumstances. All metal valves formerly employed for this purpose, and likely to get out of order, are now done away with.

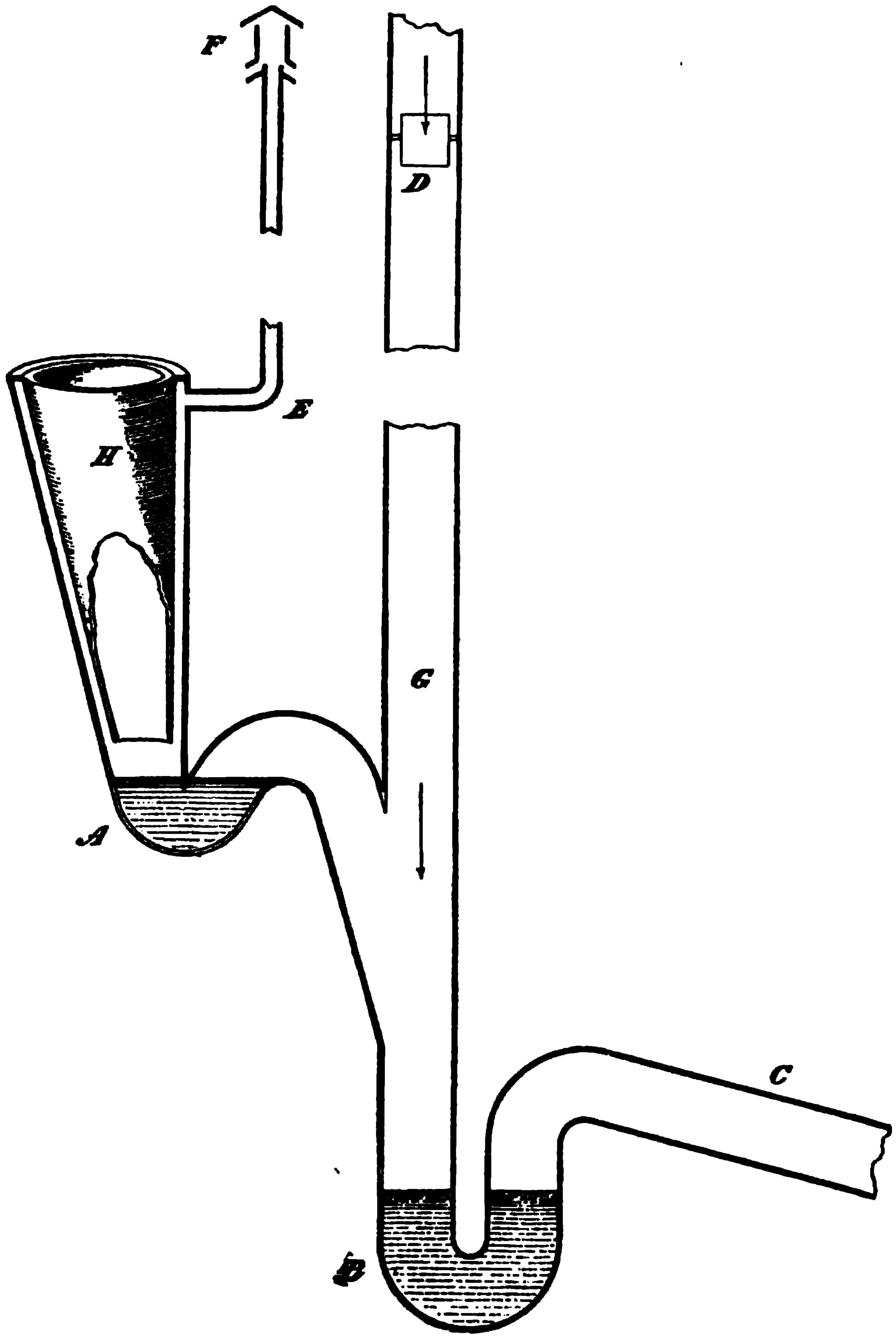
"The main pipes, into which the branch pipes discharge, are laid with a fall of one in seventy-five, without any break until near the lower end, when they are suddenly bent upwards by a siphon-pipe, so as to reach the upper part of the reservoir. On the upper part of the siphon is placed the cock which connects or disconnects the main tube with the reservoir.

"The central tubes which lead directly from the reservoirs to the central building reservoirs, communicate with the lower part of the former, by means of short pipes, and proceed in grades of one in a hundred, broken every hundred meters by a siphon rise."

Capt. Liernur's calculations of cost,* although very high, provide for the removal of excrement alone. With his system, there must be also sewers for rain-water, street-drainage, slops, etc. He would have separate pipes, too, for the drainage of the soil.

The working of the apparatus is generally satisfactory, and the four years of experience have not shown any great likelihood of its getting out of repair. Capt. Liernur states that the insides of the pipes become coated with a moist "schleimartig" (slimy) substance; the various bends in the pipes, too,

* Five million dollars, for instance, for the city of Berlin.



THE "LIERNUR SYSTEM."

(General Plan of House Arrangements.)

must serve as pockets for collecting a small amount of putrescible organic matter; but the ingenious inventor of the system naïvely says that the trap of fecal matter prevents sewer-gases from getting into the houses, as if there were not offensive gases from the trap itself.

A simple sketch by Capt. Liernur, not drawn to scale, will help to give an idea of that part of this system which is connected immediately with the houses.

H represents the seat, surrounded by a narrow, open space which communicates with the outer air by the pipe E and the ventilator F. This ventilating-pipe is for the purpose of keeping a continuous upward current, and of preventing the escape into houses of any odors from the fecal trap A, which, it is unnecessary to say, is not accomplished. The excrement at A falls by gravity-overflow into B, whence it is removed by causing a vacuum in the tank to which C leads. During the process of emptying, the external air is driven down D G, forcing the excrement before it. The charcoal-box D is supposed to be alternately fouled and purified by sewer-gases passing up, and pure air going down through it! It is Capt. Liernur's theory that A remains a constant trap of excrement, even during the process of emptying.

By the politeness of Mr. Bergsma, Secretary of the Board of Works of Amsterdam, a friend of the system, I was able to see it in actual operation.

The emptying of the tanks was complete, rapid, and, as far as I could see, successful. There was no trace of odor. In the central building, where the matter was transferred to barrels, and in its immediate vicinity, the stench was very great.

In the houses of the poorest class, where one house is used by several families, they become soiled, and in some cases filled to overflowing, before any one takes care of them. They become clogged occasionally by coffee-grounds, ashes, etc., which will find their way into them. They are not as offensive as the midden or privy, still to be found in many large cities. They are in all cases out of doors, and the people who use them prefer them to the arrangements which existed before their introduction.

In a few houses of the middle class, where they are in the

yards, a few rods from the houses, they were scrupulously clean, received frequent washing, and were not offensive.

In a primary school-house, where the closets were separated by only a narrow passage-way from the class-rooms, they were frequently washed, and, although there was a slight disagreeable odor, there was nothing really offensive at the time of my visit.* It is undoubtedly true, as the teacher said, that the closets are much more satisfactory than anything which they had ever had before.

In the houses of the better class there is so much complaint of the bad odor from the closets, that they get rid of it as best they can by flushing, with a sudden dash of a large quantity of water, after each use of the seat. Occasionally they become entirely clogged, when the odors are simply insupportable. Mr. Dyck, a resident of Amsterdam, who has also a farm in the country, states that twice in one year this intolerable stench drove him and his family entirely out of his house until the obstructions could be removed.†

Capt. Liernur proposes to meet this difficulty by automatic water-closets, using only one liter of water at each time of use; but they have not been put to the test of practice, and so small a quantity can be of no more service there than in our ordinary hopper-closets.

A part of the original plan was to sell the excrement at a remunerative price; but people of the neater class cannot be prevented from flushing their closets liberally, and the contents of the reservoirs contain so large a proportion of water as to have the general appearance of ordinary sewage, except in color. Dr. Amersfordt made a contract with the city to take the whole of it, to be delivered on his farm at 11¼ cents (U. S. currency) for each one hundred liters. The contract expired January 1, 1875, and has not been renewed, for two reasons. Dr. Amersfordt states that the distribution of

* In his official report to the Oberbürgermeister of Cologne, Stadtbaumeister Becker states that he found in these rooms an offensive odor (übeler Geruch) [Correspondenz-blatt des Niederrheinischen Vereins für öff. Gesundheitspflege, I., 131].

† Deutsche Vierteljahrschrift für öffentliche Gesundheitspflege, VII. 1, p. 24.

The closets have "ventilators," i. e., pipes running up to the tops of the houses; but at the time of my visit I found none which had any influence upon a lighted match placed at their lower apertures.

largely-diluted manure from barrels is costly and difficult; also that, when delivered to him in the winter, it is often frozen in the barrels. It is now sold for 16¾ cents (U. S. currency), delivered by boats on the farms, during the summer only. In winter it is carted down below the city and thrown into the harbor, as it cannot be sold.

At Dordrecht, this system is in process of introduction for 128 houses, with a population of 800 people, and Capt. Liernur is making preparations to make poudrette on a large scale, from which he hopes to obtain a considerable revenue. It should be remembered that a similar experiment failed in Amsterdam twenty years ago; that the Paris poudrette sold for one-twentieth of the value placed upon it by the chemists; and that an English company has become bankrupt in attempting to pay two francs a cubic meter for the contents of the cesspools in Paris, leaving several hundred thousand cubic meters at Bondy, of which the authorities would be glad to rid themselves.

The "Liernur System" has been very widely proclaimed; but, as has been seen, it has not yet met with much favor, even in Holland, to judge by the number of people now using it.

By the courtesy of Hon. Frederick Schütz, United States Consul at Rotterdam, I am enabled to publish the following valuable documents (translated), which he kindly procured and sent to the Board:—

DORDRECHT, January 20, 1876.

To the United States Consul at Rotterdam.

Complying with the request contained in your letter, dated January 10, I have the honor, in reply to the questions therein mentioned, to communicate the following:—

The Liernur system, including a central station for engines, etc., is applied in this community upon an area of about 17,300 meters, with about 800 inhabitants, distributed over 128 houses, containing 117 privies. There is a provisional project for the extension of the system, to include about 176,000 meters, with 8,640 inhabitants, in 1,273 houses, with 1,160 privies. Further, the Liernur system is to be applied to a number of separate houses, where the house-pipes unite in a reservoir, which is emptied once or twice a week by means of a movable steam air-pump (locomobile), or, in default thereof, with one worked by hand (hand-air-pump-cart). In the same man-

ner it is managed in a school, with 160 children, and this will also be done with the hospital now in construction. On building new houses, the owner is given choice between the Liernur system and the cesspool systems, the latter having obtained a large extension in the last two years. Only in the suburbs immediately on the edge of the river and its open branches are common privies allowed to discharge until further order. The extension of the above-mentioned provisional project is delayed, awaiting the results of the poudrette preparations, with regard to which it is thought that sufficient information will be obtained within a few months. This execution will only be done gradually, and will thus be divided over a great number of years. If the system remains satisfactory during that period, and it is especially evident that the preparation of the poudrette is giving favorable results, then it may be most probable that the remaining parts of the city will be supplied therewith. The experiment of the system is going on gradually, and, at all events, the practical possibility thereof is sufficiently proved; although the expenses for beginning and the difficulties connected with it, in some wards, are considerable.

With regard to the profit on the capital invested in the system, nothing can as yet be stated with certainty, as this community finds itself still too undecided to do so definitely. While the experiment is being carried on, we await more definite regulations from the person who has the contract for cleansing the city.

The Mayor of Dordrecht,

[Signed] D. W. Hoop.

Leiden, January 21, 1876.

To the United States Consul at Rotterdam.

In reply to your letter, dated January 9, by which information is requested regarding the operations of the Liernur system at this city, I have the honor to remit a printed report made by the master of works in 1873; while for further explanation, the following may be communicated: The ward or neighborhood upon which the Liernur system is applied has a surface of about 14,000 meters, with about 1,200 inhabitants, while the surface of the whole community amounts to 1,989,340 meters, with 40,000 inhabitants. The system has been in operation since February, 1872, and no complaints of any importance have been received from the tenants, neither from the proprietors of the houses nor from the directors of public institutions; while in general it may be said that in the general management not a single difficulty of any moment has presented itself. Meanwhile there exists for the present no intention to extend the system in other parts of the city, because of the considerable expense involved

in so doing. The produce of fecal material, however, has thus far covered the expenses of the experiment. From the statement of the master of works, it appears that the produce of the last nine months was, at ƒ0.30 (12 cents, U. S. currency) per 100 hectoliters; or, in all, ƒ1,130.70 ($452.28, gold). For 1873 the produce was ƒ1,496.16 ($598.46⅖, gold); for 1874, at ƒ0.40, per 100 hectoliters, it amounted to ƒ1,836.23½ ($734.49⅖, gold). After the termination of this contract, a new contract could not be made for more than ten cents, Dutch currency, or four cents, gold, per 100 hectoliters, consequently the produce per year could be estimated at an amount of only ƒ450 ($180, gold). Against this, the expenses amounted, in 1872, to ƒ3,995.04 ($1,598.01⅗, gold); in 1873, ƒ2,178.26½ ($871.30⅗, gold); in 1874, ƒ3,206.18 ($1,-282.47⅕, gold). The expenses for 1875 are estimated at ƒ2,000 ($800, gold); and for 1876, on ƒ1,760 ($704, gold). Although the experiment with the Liernur system, taken in this city from a technical point of view, may be said to have entirely succeeded, the financial results, however, must become considerably more favorable before an extension of the system will be resolved upon.

The Mayor of Leiden,

[Signed] V d BRANNDEN.

LEIDEN, April 1, 1873.

To the Magistrate, President of the Commission of Manufacturing Industry.

An application of the Liernur system was made upon a long row of small tenement-houses in the old Hoof Street, the rear bordering upon the Achter-of-Binnenvest Canal, which had been filled up in connection with the construction of sewers, and where thirty-five privies formerly discharged, free and uncovered; further, upon both sides of the Yarn Market and St. James Canal, with the largest part of the Fame Alley. The discharge-pipes of the privies from all the tenements in these streets came together in the two main sewers of the Yarn Market and St. James Canal, which were running by two outlets into the above-named rear canal; so that this canal, being without a direct stream running through it, and also narrow and shallow, without fence or walls, formed, literally, an open sewer. This condition, which repeatedly proved to be unbearable, especially at a breaking out of contagious diseases, together with the then pending projects for an improvement thereof, gave ample reason for making a trial of the Liernur system. The number of buildings in the above-mentioned ward to be supplied with the pipes, including the stables, coach-houses, working places, and the Roman Catholic asylum for orphans and aged people on the St. James

Canal, in which 177 orphans and old people were provided for, amounted to 126, with full 977 inhabitants, to whom are to be added 400 children in an infant school on the Yarn Market. Leaving out the half of this number of children as being present only during the day, the population can be estimated at 1,200. The number of privies in the tenements and establishments is 166. Among those, twenty-six are on upper floors. The old main sewers, privy branches and spouts were allowed to remain for the purpose of carrying off rain, wash, and factory water, in connection with a new constructed water-channel in the (filled up) rear canal. The expenses for arranging the pipes with appurtenances, placing reservoirs with ground-work, attaching the privy funnels, and repairing mutilated floors, ceilings, walls, etc., the procuring of a steam-engine (locomobile), conveying wagon or tender, with tubes, cranes and many other necessary appliances amounted to

	ƒ26,816 88½	($10,726 75⅖)
According to a specified estimate by Messrs. Liernur and De Bruyn-kops, the work was to cost . . .	22,000 00	(8,800 00)
So that beyond the estimate there was still demanded	ƒ4,816 88½	($1,926 75⅖)

This considerable excess beyond the estimate was especially due to an account of Liernur & De Bruyn-kops, for engineers' salaries, travelling expenses, expenses of an engineer's overseer, in charge of the arrangement, and extra fees of a machinist for levelling. All this, with one thing and another, was not taken into account in the estimate; it is also due to a great many special expenses, which the contractors could not foresee, and which demanded some indemnity. Also, there are to be taken into consideration the expenses of experimenting during the year 1871, which had to be made from pipe to pipe, as the pipes were laid, of which no separate account could be kept. The expenses of experimenting during the year 1872, in which year a regular collecting and transportation of the fecal material took place, amounted to the sum of

	ƒ3,995 04	($1,598 01⅗)
No contract for the sale of this fecal material, upon fairly reasonable terms, could be made until April 1. The sum received during the last nine months of 1872, for 3,790 hectoliters at 30c. (12c. U. S. currency, gold) per 100 hectoliters, was	1,130 70	(452 28)
Consequently, a deficit of	ƒ2,864 84	($1,145 73⅗)

To this is to be added the expense of transporting the engine and tender with horses to a distant pumping-station, .	*f*1,262 50	($505 00)
	*f*1,601 84	($640 73$\frac{3}{5}$)
Could the contract have been made for the whole year, on the same terms, the deficit would have been decreased by .	376 90	($150 76)
	*f*1,224 94	($489 97$\frac{3}{5}$)

The great expenses for transporting the engine by horses, and the damages caused to it by the jolting and shocking in moving, led the authorities to decide upon an experiment with a stationary engine. During the last months of the year a new building was erected for the above purpose, in a suitable location; all necessary appliances were provided, and for this there was made an appropriation to the amount of . . . *f*7,200 00 ($2,880 00)

Adding to this the first expenditure, .	26,816 88$\frac{1}{2}$	(10,726 75$\frac{3}{5}$)
The total expense amounts to . . .	*f*34,016 88$\frac{1}{2}$	($13,606 75$\frac{3}{5}$)

While it cannot be denied that the expenses of introducing the system and the necessary experiments were greatly in excess of what was anticipated, that the amount received for the fecal material was less than was anticipated, and that the interest on the money and the instalment paid must be taken into account, yet a favorable judgment, as to the result, must remain. This trial of the Liernur system has proved at least this: That it is possible to remove all fecal material from tenements in an easy way, free from all annoyances, and that the collecting, loading and transportation thereof can be done wholly without odor, and before any results detrimental to health can arise from escaping gases. Therefore the great question concerning this matter is to be looked upon as entirely settled, and the system deserves recommendation to extension everywhere as well as in this city. Finally, there may be added to this that the expenses for experimenting, repairs, etc., for the current year 1873 are estimated at *f*2,000 00 ($800 00)

While the produce of the fecal material, at the rate of 1872, will amount to .	1,407 60	(563 04)
Making a deficit of	*f*592 40	($236 96)

It cannot be superfluous to mention, that although the nitrogenous elements upon which the value of the fecal material for the agriculture depends, and which Mr. Liernur estimated at 0.9 per hundred,

were found upon chemical examination to fall even below half this per cent.; and that Mr. J. C. Van de Blocquery, writing, as a farmer, to the Master of Public Works at Amsterdam (which letter appears in the public reports of that city for the year 1872, page 976), in the most positive terms expresses his special satisfaction with the results obtained by him with this fecal material at various trials on his land in the Haarlem lake polder. This letter closes with the following words: "I cannot comprehend what advantage there can be found in prejudicing the public against this manure, and calling it only sewer-water; and I regret this very much. By this opposition to the taking of the manure by means of a certain mixture (or composition), the town municipalities might easily be persuaded to give up a further extension or application of the Liernur system; and by this agriculture would suffer, beyond any doubt.

The Master of Public Works,

[Signed] J. W. SCHAAP.

It will be seen, from the letter of the mayor of Leiden, already given, that opinion has changed somewhat since the publication of this official communication, nearly three years ago.

EXPERIENCE IN OTHER COUNTRIES.

In Belgium and Flanders, human excrement has been used in agriculture from time immemorial, and the fertility of the soil is largely attributed to this fact. The nuisance, however, is great; and those substances which destroy the smell (the sulphates of iron, copper and zinc, chlorides of manganese and iron, etc.,) diminish the value of excrement as manure. In the more populous places, therefore, sanitary measures are beginning to be considered of more importance from year to year; and the idea has obtained that the first requisite is complete and inoffensive removal of filth. Very few of their cities, however, have yet undertaken any extensive works for this object. Brussels has a long intercepting sewer, discharging into, and seriously polluting the Senne, a small stream running through the valley and dividing the city into two parts. In 1861, and again in 1865, commissions were appointed to consider the subject of the disposal of the city's filth; the result of their investigation is embodied in the following extract from their report:

"The chemical (precipitating) processes employed up to the present day for separating the valuable parts of sewage have given unsatisfactory results. Irrigation only has proved sufficient for purifying sewage." *

The commission of 1865 visited the precipitating works at Leicester, England, and found that "the precipitates gave rise to an insupportably fetid odor, which extended a great distance." † An English (Belgian Public Works) Company has taken a contract to provide the city with a main-drainage system, of which irrigation with the sewage is to form a chief part. Imperfect irrigation is carried out at St. Étienne.

In Switzerland, subsoil-irrigation has been used to some extent without much success. A complete system of sewerage, with irrigation, is to be carried out for Zürich, as soon as satisfactory arrangements can be made.

Near Florence, an experimental sewage-farm was begun in 1874, and, thus far, has given satisfaction.

Two thousand acres near Milan have been successfully cultivated, under a system of irrigation, for many years. The sewage here is twenty times more dilute than that of Paris, or of most of the English cities.

In Spain, few rivers are polluted. The sewage of Valencia is used in irrigation; but, as is the case at Milan, it is the river that is used for this purpose, and it is simply an accident that its waters are polluted by the filth of a large city.

In the United States, a few insane-asylums are making attempts to utilize their sewage by irrigation. Mr. C. B. Lakin, at the State Asylum at Augusta, Me., has had excellent results from his experiments.

Processes for Purifying Sewage.

Deodorization.

"Deodorizers" and disinfectants for sewage have been proposed,—in all more than sixty,—and used, in the laboratory at least, for the past century. Chloride of lime and perman-

* "Les procédés chimiques employés jusqu' à ce jour pour les extraire des eaux d'égouts ont donné des résultats peu satisfaisants; l'irrigation des prairies a seul promis d'utiliser et de purifier ces eaux d'une manière constante."

† "Les produits recueillis répandaient au loin une odeur fétide et insupportable."

ganate of potash are the only ones that have proved satisfactory, and their enormous cost makes it impossible to use them on a large scale.

The Metropolitan Drainage Commission of London made extensive experiments, in 1857, with all the prominent deodorizers that could be used without incurring inordinate expense. Their experience is summed up in the following words:—

"The most favorable result was obtained by the filtration of sewage through charcoal. The liquid which first passed off was quite clear and free from smell, but by analysis it was shown to contain a large amount of highly putrescible organic matter in solution. After a time it lost its color, and the smell returned. But, on continuing the process of filtration, the charcoal even loses its power; and consequently the expense of deodorization by this agent, even to the limited extent shown, becomes enormous." Carbolic acid in large quantities, even when mixed with tar, only *arrested* decomposition; the effluent finally became turbid.

At Croydon, twenty years ago, there were tried, one after the other, lime, charcoal, carbolic acid, perchloride of iron, etc. Mr. Johnson, then chairman of the local board of that place, testified with regard to them as follows:—

"The failure was that they still left the sewage in so impure a state that the people on the river objected to the sewage being discharged into the river."

He stated also that the reagents were all very expensive; so that irrigation was finally chosen as the cheapest and best method of disposing of the sewage.

Filtration.

Among the earliest experiments in England, filtration, both upward and downward, was attempted, the filters being made of sand, gravel, charcoal, sawdust, etc. This process has always failed to do more than intercept the solid portions of the sewage, and has now been abandoned, except in connection with irrigation.

The Sewage of Towns Commission of England, in their second report, speak of the experience of Birmingham, thus: The downward system was soon given up as impracticable.

The upward filter was maintained in operation for some time longer, but was ultimately abandoned as practically useless." . . . "The filters choke immediately, and become impervious to the passage of the liquid." *

The First Rivers Pollution Commission say: "As applied to sewage, disinfectants do not disinfect and filter-beds do not filter. Both attempts have been costly failures."

Intermittent Downward Filtration.

As the result of experiments in his laboratory, Prof. Frankland concluded † that land exposed alternately to the free action of the air and the sewage, would so oxidize and decompose and filter the latter, that it might be safely discharged into streams. In such case, it would be necessary to filter the sewage roughly before applying it to the land, in order to rid it of solid matter.

Mr. J. Bailey Denton has made the only practical trials of this method at Kendal, England, and at Merthyr Tydfil, Wales. One advantage is, that so small an area of land, one acre for each one thousand inhabitants, is sufficient for carrying out the system. Where only a few acres can be bought, especially if the soil is loose and open, it seems to be the most feasible plan for inland towns lying on small streams.

The Rivers Pollution Commission arrived at the following conclusions in regard to this process.

"Sewage traversing a porous and finely-divided soil undergoes a process to some extent analogous to that experienced by blood in passing through the lungs in the act of breathing. A field of porous soil, irrigated intermittently, virtually performs an act of respiration, copying on an enormous scale the

* In many cases, filters for ordinary drinking water have become so clogged in a short time as to render the water more impure after treatment than before.

† "The results of these experiments were to prove that intermittent downward filtration effects a very satisfactory purification of the water, when the amount of sewage does not exceed five and one-half gallons per cubic yard of filtering material in every twenty-four hours; and further show, by the presence of nitrogen in the form of nitrates and nitrites, that the process is essentially one of oxidation. The organic matter in the sewage stream is, to a large extent, converted into carbonic acid, water, and nitric acid; hence the necessity for the continual aeration of the filtering medium, which is secured by intermittent downward filtration."

lung-action of a breathing animal; for it is alternately receiving and expiring air, and thus dealing, as an oxidizing agent, with the filthy fluid passing through it. The action of earth as a means of filtration must not be regarded as simply mechanical; it is chemical, for the results of filtration, properly conducted, are the oxidation, and thereby the transformation, of the offensive organic substances, in solution in the sewage stream, into fertilizing matters which remain in the soil, and into certain harmless inorganic salts which pass off in the effluent water."

The requisites in practice are found by Dr. Dyke, from his experience at Merthyr Tydfil, to be as follows:—

"1. The soil of the land to be used must be porous.

"2. A main effluent drain, which must not be less than six feet from the surface, must be provided.

"3. The surface of the soil to be so inclined as to permit the sewage-stream to flow over the whole land.

"4. The filtering area should be divided into four equal parts, each part to be irrigated with the sewage for six hours, and then an interval of eighteen hours to elapse before a second irrigation takes place; each of the four parts would thus be used for six hours out of the twenty-four. An acre of land, so prepared, would purify 100,000 gallons of sewage per day."

It was thought, at first, that when so great an amount of sewage was used it would be impossible to raise crops, but experience has proved the contrary to be the case. At Kendal, even a smaller amount of land has been used than at Merthyr Tydfil; namely, five and one-half acres for 13,500 people; and this disposes of an average of 975,000 gallons daily.

The cost of this system is somewhat greater than that of ordinary irrigation, inasmuch as the return from the crop raised is much smaller.

Precipitation.

The first experiments for accomplishing a solution of the sewage-question were made in Paris over a century ago,*

* The irrigation with sewage at Edinburgh was simply a financial project, and had no reference to sanitary requirements.

the object aimed at being the removal of the valuable parts of the sewage, so as to get them in a compact form.

To accomplish this result, over sixty different methods have been suggested at different times, most of them attempting some process of precipitation. Many of these methods are essentially repetitions of others which had been previously tried. All of them have proved failures.* No process at present known to the chemist, except the costly one of evaporation, can remove from sewage any large part of its valuable constituents in solid form. Hoffman and Witt show in the following table (the result of numerous analyses made for the Metropolitan Drainage Commission of London), that six-sevenths of the valuable matters of sewage are in solution:—

Value of One Hundred Tons of Sewage for Irrigation.

	Valuable insoluble matter.	Valuable soluble matter.	Total.
	s. d.	s. d.	s. d.
In its original state,	2 2½	15 4½	17 7
After treatment with lime,	–	11 11	11 11
After treatment with lime, sulphate of alumina and charcoal,	–	12 5	12 5
After filtration through charcoal,	–	11 1¼	11 1¼
After slaking with peat-charcoal,	–	10 11¼	10 11¼

In the first report of the Second Rivers Pollution Commission of England, are given the statistics from which the

* The testimony of Mr. Robert Rawlinson, C. E., C. B., now chief engineering inspector of the local government board, was given in the third report of the Sewage of Towns Commission, in 1865, as follows: "Experience, so far as carried, proves that fluid sewage cannot be manipulated into a solid manure so as to pay. There have been attempts at Leicester, at Tottenham, and, for a time, at Croydon. During the continuance and working of these sewage-works, there was the greatest possible nuisance, with no paying result. At Leicester, the solid which was expected to sell for four pounds per ton, could not be sold for four shillings a ton. At Birmingham, the sewage-sludge accumulated beyond the power to sell it for sixpence a ton. At Leamington, there is an annual cost, at the outlet works, of some £400 to precipitate and remove the sludge from about one million gallons of sewage per day. At Cheltenham, Coventry, Worksop, and at some other places, the separated sludge is sold at prices ranging from one shilling to two shillings per ton! In all these cases, the fluid—the true sewage—is wasted."

following table is condensed. The results are of experiments made July 30 and 31, and August 1, 1868, with the sewage of Leicester :—

Average Composition of Sewage.

[Results expressed in Parts per 100,000.]

COMPOSITION OF SEWAGE.	AVERAGE OF THREE DAYS.		
	Before any treatment.	After treatment by the lime-process.	After treatment by the A. B. C.-process.
In Solution.			
Total solid matters,	110.	91.66	120.33
Organic carbon,	3.344	2.570	2.374
Organic nitrogen,	.524	.248	.322
Ammonia,	1.550	1.975	2.333
Nitrogen, as nitrates and nitrites,	.007	.008	0.000
Total combined nitrogen,	2.096	1.903	2.244
Suspended Matters.			
Mineral,	23.15	3.19	1.59
Organic,	32.02	1.94	2.82
Total,	55.17	5.13	4.41

These tables furnish the key to the whole question, and show why the precipitating processes have all proved unsatisfactory. The effluent from them all is essentially *sewage*.

The more important of these processes are as follows :—

The Lime-Process.

Fresh milk of lime is added to sewage in varying quantities, generally about a ton of lime to 1,225,000 gallons of sewage.* They are thoroughly mixed, and after standing for some hours in settling-tanks, the mud settles to the bottom, and the liquid is drawn off. A slight flocculent coagulum is seen in the sewage during precipitation, and about one-fourth of the soluble organic matter is carried down, in part mechanically, in part as carbonate and phosphate of lime. A certain

* This quantity varies somewhat in different towns, according to the weather, the composition of the sewage, and its freshness or otherwise, etc., from three to sixteen grains of lime to a gallon of sewage. The precipitate weighs from four to five times as much as the amount of lime used.

portion of the ammonia is set free by the stronger alkali, and is one of the readiest vehicles of noxious vapors. The precipitate contains a large amount of sulphide of lime, a very unstable salt, which allows sulphuretted hydrogen to escape during the process of drying, giving rise to a very offensive smell. A small part of the sulphuretted hydrogen remains in the effluent. The fluid, therefore, is subject to ulterior change, and becomes itself a serious nuisance, unless mixed with a large quantity of flowing water, or purified by irrigation. Charcoal and other disinfectants have been used to remedy these evils, but they only increase the cost without materially changing the result. Experiments by Hoffman and Frankland show that, in the moderate climate of England, the effluent begins to putrefy after standing forty-eight hours; the addition of chloride of lime somewhat delays this process.

The famous Leicester bricks * were made, twenty years ago, of sewage treated by this process. Versmann gave them a value of seventeen shillings to the ton, while Voelcker estimated them to be worth fifteen shillings and fivepence. The processes of making these bricks cost three shillings a ton; their market price in 1866 was one shilling.† In some places in England they can hardly be sold at any price.‡

The lime-process was tried at Birmingham, where land for

* So called because the mud was dried in the shape of bricks.

† In 1870, four million gallons, the sewage of 95,000 people, were treated in this way, and the sludge was spread out on two acres and a half to dry. The yearly expense was £4,800; the "bricks" sold for £300, so that the loss was £4,500. As to the present condition, Dr. J. Wyatt Crane, health officer of Leicester, writes, under date of February 11, 1876: "Our sewers still discharge their contents into the river, but we are striving to diminish the amount of fecal matter as much as possible. We have adopted for this purpose, the system which originated in Rochdale, and which is called the pail system, and consists of a galvanized pail placed under the seat, which is removed once or twice a week, in a vehicle constructed for the purpose, and conveyed to a depot, where it finds customers among the neighboring farmers, and, I need not say, is an excellent manure. As a part of the system, the large ashpits, which were the receptacles for every kind of refuse, are done away with, and are constructed so small as to contain nothing but ashes. The better class of houses are supplied with water-closets, of which there were, three years ago, 8,400 in the whole town. The contents of these are carried into the sewers, and finally conveyed into the river. Parliament will be compelled to legislate ere-long upon this question."

‡ A large part of the phosphoric acid was found to be in an insoluble and comparatively valueless form.

irrigation could not be obtained; but the trouble with it was so great, that the mayor and council sent a memorial to parliament, complaining "that the grosser and more solid matters contained in the sewage when so intercepted are in the condition of wet mud, the peculiar character of which prevents its drying so that it may be removed, and it is impossible to remove it until it has lain upon the surface of the earth for several months; that the consequence of this state of things is, that since the first commencement of the system of interception, an area exceeding seven acres in extent is covered to a depth of four feet with such grosser or more solid parts of the sewage, and your memorialists are at present unable to remove it, for the reason already stated." The stench became so great, and the complaints so frequent, that an injunction was finally served against the city.

The effect upon the rivers of carrying out the lime-process is, that fishes return to them in some cases, and the streams become clear. Dr. Buchanan states that such was the case at Leicester, in 1866.* But the clarification of the sewage does not approach the standard of purity of the Rivers Pollution Commission.

The Alumina-Processes.

Alumina, especially when precipitated from its sulphate by lime, separates in a bulky form, and has the property of forming with organic matters somewhat stable compounds of gelatinous consistency, which carry down a considerable quantity of matter in suspension. The result is not very different from that of the lime-process. The whole of the phosphoric acid is saved, but not the ammonia. As so large an amount of foreign matter is added which has slight value as manure (720 pounds of clay and 120 pounds of sulphuric acid to each 150,000 gallons of sewage) the precipitate is of even less value than that obtained by the lime-process. An equally large amount of putrescible matter is allowed to escape by both methods, and the effluent becomes putrid in a short time.

These processes have been modified somewhat in different places in many non-essential details, and they have been

* Compare Dr. Crane's letter as to the present condition, page 329.

made the bases of extensive experiments in England, France, and Germany; but all agree in showing that the alumina-processes are more costly than the lime, the precipitate is of less value, and the effluent is equally putrescible.

The Superphosphate-Process.

This was supposed to fix the ammonia by forming a double phosphate of magnesia and ammonia; but this salt is soluble in water, especially in water containing common salt and other compounds found in sewage; so that the whole method is useless, beside being costly.

The Sulphite-of-Lime-and-Magnesia Process.

Sulphurous acid was expected to destroy the sulphuretted hydrogen, and it did so; but it is itself liable to change, and unless used in great excess is of little value. It was found in practice that decomposition took place in the effluent, causing offensive odors, while the precipitate was sold with difficulty at a shilling a ton.

The A. B. C.-Process.

The Messrs. Sillar patented this process, and so much was claimed for it, that the Rivers Pollution Commission of England made it the subject of one of their reports. The idea was got from the Mosaic law. The materials used, and their proportionate parts by weight, are as follows: Alum, 600 parts; blood, 1; clay, 1,900; magnesia, 5; permanganate of potash, 10; burned lime, 25; salt, 10; animal charcoal, 15; vegetable charcoal, 20; bi-carbonate of magnesia, 2.

From four to ten pounds of this mixture are stirred up with one thousand gallons of sewage until no further precipitate is produced. What effect eleven grains of blood are to have on a thousand gallons of sewage, it would be difficult to say.

The process now in use at Leeds is in accordance with the following modified formula: Alumina (impure sulphate), 400 parts (by weight); blood, 10; clay, 2,240; charcoal, 400. Total, 3,050.

Three times as much of this is used as of the original mixture.

The Rivers Pollution Commission give the following results of their examination of the Sillar process:—

"1. The process precipitates the greater part of the solid particles of the sewage, but in no case to such an extent as to allow the superincumbent waters to run into a river.

"2. The process produces no clearer water than what would have resulted if the sewage were allowed to settle by itself.

"3. The sewage is considerably reduced in value through it.

"4. Bad smells are always perceptible."

The precipitate was found to be of somewhat greater value than that obtained by the use of lime; but the proportional amount of cleansing of the sewage by the two processes was substantially the same.

Precipitation by Metallic Salts.

This has been found the most satisfactory of all the ways of removing the noxious ingredients of the sewage in solid form. The perchloride of iron has generally been used, as being the cheapest; though even that is too expensive for general use on a large scale. It settles readily in the form of a heavy precipitate of the peroxide, carrying down mechanically a very large part of the suspended matter. The sulphuretted hydrogen, too, is fixed in a stable form as a sesquisulphide. The ammonia, however, remains in solution, and the effluent putrefies to a certain degree, after a time.* The nitrogen and the phosphoric acid in the mud formed are in a condition to be used as manure, so that the precipitate has a greater theoretical value than some of the others. It sells for about the same price, however, as the difficulty of transportation is so great as to form the chief element in establishing its worth.

Suvern's System.

This process uses the following mixture: water, 240 parts; chalk, 100 parts; coal-tar, 18 parts; chloride of magnesium, 10 to 70 parts.

Experiments with this mixture have been made by a com-

* According to Hoffman and Frankland, in nine days during warm weather.

mission in Berlin, with the following results: The precipitate formed rapidly, leaving the fluid clear, but containing a large part of the ammonia. Few bacteria were found at once, but in a few days the effluent seemed swarming with living organisms. One thousand parts of the fluid contained 1.5 parts of solid matter and a large part of the urine in a decomposed condition. It was unfit to be run into the rivers. The precipitate contained 21.1 parts of organic matter in 100; and in this organic matter 0.7 per cent. was nitrogen and 1.5 per cent. phosphoric acid. It was found not to be worth enough to pay for cartage and labor, as the process costs sixty cents a year for each individual of the population.

Lenk's Process

Has been also tried by the same commission in Berlin. The mixture consists of alum, soda and chloride of iron or zinc. The precipitate formed slowly. The bacteria were not killed. The general results of these experiments were pretty nearly the same as by Suvern's process. Both methods were declared inferior to irrigation.

This list might be extended almost indefinitely, and seems to be limited only by the bounds of human credulity. In France and Germany the precipitating processes have been given up as inefficient. In England, a new "successful" patent process is hawked about every few months, to be soon found only an addition to the list of failures; and the public is perfectly bewildered by the maze of conflicting statements and propositions. In some cases, however, cities have been driven to the precipitating process because they could not get sufficient land to deal with their sewage in any other way. In such cases, the difficulty has been to get rid of the precipitate. An ingenious and satisfactory method of doing this has been recently patented by Major-General H. Y. D. Scott. It consists in burning the mud, and making cement of a very fair quality. It is not a remunerative procedure, but has been found quite satisfactory at Birmingham, where three tons are made each week.

IRRIGATION.

The irrigation of land with sewage may be performed in one of three ways.

1. By the use of hose to sprinkle the land.
2. By the use of pipes under the surface.
3. By the use of open pipes or trenches on the surface.

The first is the simplest method, and one of the earliest suggested. It was soon abandoned, however, because experience has shown that it is best not to expose the leaves of growing plants to the direct action of any manure. It is of use on a small scale, with sufficient care in managing it.

Subsoil-Irrigation.

This method was practised in Switzerland at one time, but was soon found to be too costly for use on a large scale. For the disposal of the sewage of a small number of people, where there is an abundance of land, the system is an excellent one. It has been used by Mr. Rogers Field, C. E., of London, with admirable success. The sewage is carried to a safe distance from the houses in tight pipes, and is then distributed in open jointed pipes about one foot below the surface of the ground.* Subsoil-drains are placed at a depth of four feet to carry off the purified liquids. Col. G. E. Waring has used a similar method in Newport, which he describes as follows:—†

"The house drainage is discharged into a tightly-connected and thoroughly-ventilated tank. Its outlet-pipe, starting from a point one foot below the surface of the water, and about two feet below the cap-stone, passes out near the surface of the ground, and is continued by a cemented vitrified pipe to a point about twenty-five feet farther away. Here it connects with a system of open-jointed drain-tiles, consisting of one main fifty feet long, and eight lateral drains six feet

* Mr. Field is of the opinion, from his experience, "that four perches would be sufficient ground for the effective disposal and utilization by sub-irrigation of the slops from an ordinary cottage." [*On Excrement Nuisances*, by Mr. J. Netten Radcliffe; Second Report of the Medical Officer of the Privy Council and Local Government Board of England, p. 233.]

† "The Sanitary Drainage of Houses and Towns," Atlantic Monthly Magazine, No. 216, 1875, p. 428. It should be said that earth-closets were used by Col. Waring, as an adjunct to this system.

apart, and each about twenty feet long. These drains underlie a part of the lawn, and are only about ten inches below the surface." If made again, he would have the pipes three feet apart. The slope from one extreme of the system to the other is only fifteen inches. The pipes require cleaning about once a year.

Surface-Irrigation.

In Egypt and in India surface-irrigation has been used on an enormous scale. In Lombardy and Piedmont many million acres of land are so irrigated at the present day.* In all these places, the process has been carried out simply with reference to the large profits which result from it. No sanitary laws are considered. In fact, the irrigated fields are at some seasons of the year covered with a stagnant fluid, and diseases of the intermittent type are prevalent.

The experience of these countries led some private individuals in Edinburgh to make a similar attempt there about two centuries ago. The result could not then have been satisfactory, as the scheme was not extended until about a century and a half later.

Thirty years ago, an experiment was made in England in utilizing the sewage of one of the insane-asylums of the kingdom,† and ten years later Rugby, Croydon, and a few other towns took the lead in attempts to *purify* sewage by irrigation, without any view to large profits.‡ Their experi-

* In the valley of the Connecticut River a large area is so fertilized from being overflowed by the yearly rise of the water, that it requires no other manure. This natural irrigation has brought the land to a high state of fertility; so also in the Mohawk Valley, and probably in others throughout the country.

† In 1848, the Metropolitan Sewage Manure Company used the sewage of a part of London to irrigate their garden near Fulham. Strawberries and other fruits were raised, as well as vegetables. The experiment proved satisfactory in every way, except that it was not successful financially. The company could not compete with other farmers who brought back from the city in their market-wagons (otherwise empty) stable-manure which they bought there at low rates.

‡ This was recommended as a sanitary measure by Mr. Edwin Chadwick, in 1842. In the first report of the Health of Towns Commission, Mr. P. H. Holland states that such operations must prove remunerative when properly conducted; an opinion which is now gaining ground, in spite of numerous failures.

The First River Pollution Commission quote and indorse the following

ence was such as to give the impression that large profits were to be made in the work; and the high theoretical value given to sewage by Baron Liebig, in his letters, only encouraged this idea. In individual cases, it was found that by soaking the ground with sewage, without special attention to sanitary laws, enormous crops of grass could be raised at slight cost. The products of a single acre at Edinburgh sometimes sold for over two hundred dollars; but it was soon found that there is only a limited demand for fresh grass in any town, and that irrigation, to be carried on so as to avoid offence, is not a cheap process.

The Sewage of Towns Commission of England tried some very interesting experiments at Rugby in 1861, 1862, and 1863, and their results, the most complete ever obtained, are given on the following page.* The land was divided into four parts, and treated,—

Lot 1. Without sewage.
2. With 3,000 tons of sewage per acre per annum.
3. With 6,000 tons of sewage per acre per annum.
4. With 9,000 tons of sewage per acre per annum.

The different plots were of the same size, and as nearly alike in other respects as possible.

Another table is given (see p. 338), showing the per cent. of dry substance found in the various crops. The plots and the quantities of sewage used on each are as in the table on page 337. The crop raised each year was meadow-grass.

statement of the Sewage of Towns Commission: "When local circumstances are favorable, and undue expenditure is avoided, towns may derive profit more or less considerable by applying their sewage in agriculture. Under opposite circumstances, there may not be a balance of profit; but even in such cases, a rate in aid, required to cover any loss, need not be of large amount."

* Third Report, Sewage of Towns Commission, 1865, p. 6.

Results of Three Years' Experiments at the Sewage-Farm in Rugby. Grass raised in 1861, 1862, 1863, measured in tons, cwts., qrs., and lbs.

YEAR.	Five-Acre Field.																Ten-Acre Field.															
	Without Sewage.				With Sewage.												Without Sewage.				With Sewage.											
	Lot 1				Lot 2				Lot 3				Lot 4				Lot 1				Lot 2				Lot 3				Lot 4			
	tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.
1861, ...	9	5	3	5	14	16	3	8	27	1	0	10	32	16	3	8	8	18	0	15	15	16	3	2	22	15	2	12	26	13	3	12
1862, ...	8	3	1	10	27	18	0	18	34	10	0	19	32	9	2	22	16	10	0	25	27	11	0	20	32	2	1	14	31	12	1	20
1863, ...	4	18	3	13	22	5	0	11	34	18	1	27	37	0	2	5	8	0	3	19	25	5	1	8	30	11	2	12	34	19	1	21
Average, . . .	7	9	1	9	21	13	1	12	32	3	1	0	34	2	1	12	11	3	0	10	22	17	3	1	29	9	3	13	31	1	3	18

Per cent. of dry substance in Crops.

Number of Crop.	Five-Acre Field. Without Sewage. 1	Five-Acre Field. With Sewage. 2	3	4	Ten-Acre Field. Without Sewage. 1	Ten-Acre Field. With Sewage. 2	3	4
1861.								
1,	27.9	30.5	26.9	27.7	22.	23.3	21.4	18.4
2,	24.4	19.8	14.2	13.3	26.9	17.1	15.1	16.1
3,	–	13.4	13.7	12.9	–	12.6	7.3	14.4
4,	–	–	15.4	9.6	–	16.9	15.1	17.8
Mean,	26.2	21.2	17.6	15.9	24.5	17.5	14.7	16.7
1862.								
1,	26.7	22.8	14.4	15.3	26.9	19.5	13.5	13.1
2,	22.8	14.3	16.4	19.4	17.9	16.2	19.	16.7
3,	–	18.2	12.9	14.2	–	14.5	14.4	15.8
4,	–	–	–	–	–	–	33.8	33.8
Mean,	24.8	18.4	14.6	16.3	22.4	16.4	15.6	15.2
1863.								
1,	36.1	21.5	17.6	16.3	39.8	18.6	20.	14.6
2,	34.4	18.5	14.9	17.8	18.2	17.7	16.3	18.8
3,	–	17.7	10.9	17.6	–	12.4	14.6	15.2
4,	–	15.8	13.	12.3	–	–	13.9	13.6
5,	–	–	–	15.3	–	–	–	–
Mean,	35.3	18.4	14.1	15.9	29.	16.2	16.2	15.6

The results of analyses by J. B. Lawes are given in the following table, and show the effect of sewaged grass on the milk of cows:—

	Cows fed on Grass alone. Unsewaged, mean of nine samples.	Cows fed on Grass alone. Sewaged, mean of ten samples.	Cows fed on Grass and Oil-cake. Unsewaged, mean of four samples.	Cows fed on Grass and Oil-cake. Sewaged, mean of four samples.
Caseine,	3.246	3.241	3.352	3.423
Butter,	3.604	3.430	3.657	3.707
Sugar of milk, etc.,	4.405	4.218	4.561	4.689
Mineral matters,	.753	.776	.740	.771
Total solids,	12.008	11.665	12.310	12.050
Water,	87.992	88.335	87.690	87.950
Total,	100.	100.	100.	100.

The commissioners state, as the result of their experiments, that "analysis shows very little difference in the quality of the milk yielded respectively from sewaged and unsewaged grass. The difference in composition, such as it is, is slightly in favor of the milk from the unsewaged grass, when grass was given alone, and slightly in favor of the sewaged grass when oil-cake was given in addition."

The First Rivers Pollution Commission say: "The grass is not only wholesome, but cows fed upon it give richer milk, from which first-class butter is made."

Lawes and Way give the following summary of the whole series of investigations, extending over three years:—

"Taking the average over three years, and in the two fields, the amount of produce obtained without sewage was about 9¼ tons of green grass per acre per annum, equal to about three tons of hay; and with 3,000, 6,000 and 9,000 tons of sewage per acre per annum, the amounts were, respectively, about 22¼, 30¼ and 32½ tons of green grass, equal, respectively, to about 5, 5¾ and 6½ tons of hay.

"When cut and given to fattening oxen tied up under cover, more sewaged than unsewaged grass, reckoned in the fresh or green state, was both consumed by a given weight of animal within a given time and required to produce a given rate of increase; but of real dry or solid substance less of that of the sewaged than of the unsewaged grass was required to produce a given effect.

"When cut grass was given alone, the result was very unsatisfactory; but when oil-cake was given in addition, the amount of increase upon a given weight of animal within a given time, and for a given amount of dry substance of food consumed, was not far short of the average result obtained when oxen are fed under cover on a good mixed diet.

"When cows were fed on unsewaged or sewaged grass, as much as they chose to eat, a given weight of the animal was more productive, both of milk and increase, but especially of milk, on the unsewaged than on the sewaged grass.

"From a given weight of unsewaged grass, reckoned in the fresh or green state, more milk was produced than from an equal amount of fresh sewaged grass; but a given weight of the dry or solid substance supplied in sewaged grass was,

on the average, more productive than an equal weight supplied in unsewaged grass.

"By the aid of sewage, the time that an acre would keep a cow, and the amount yielded from the produce of an acre, were increased between three and four fold.

"The sewaged meadow grass, as cut and given to the animals, contained a less proportion of dry or solid substance than the unsewaged.

"The proportion of nitrogenous, and also of impure waxy or fatty matter, was much greater in the solid matter of the sewaged than in that of the unsewaged grass."

The Mode of Distributing Sewage.

This will be best understood from a description of individual farms. A few of the principles only will be given here.

In the first place, the land must be prepared so that the beds shall have a slope varying from 1 in 50 to 1 in 150. If not loose and porous, the land must be underdrained.* The sewage must be delivered (by pumping if necessary) at the highest point on the farm, whence it is distributed by gravitation.

The main carriers may be open, and of cement, or, preferably, of Scotch clay pipe. The laterals are generally simple trenches dug in the earth, a few inches deep. On some farms the main conduits are simply trenches dug in the ground. Of course they require frequent cleansing to prevent deposits on their sides and bottoms.

The sewage flows uniformly over the surface of the land, each plot being irrigated for a few hours at a time, and once in every three to twelve days, as is necessary; grass, for instance, may be treated much oftener than vegetables.

The accompanying plates illustrate the process as generally used.

Fig. I represents the process as generally used. A F is the main sewage-delivering conduit, which is dammed at various points, as required, by the gate F. By opening the gates G, any trench, B D, C, etc., may be made to distribute

* The amount of underdraining generally found necessary in ordinary farming is sufficient, and the same rules apply to both cases.

Fig. I.

Fig. II.

the sewage over any part of the field, and the flow is limited by placing the dam D at any point desired. The fluid flows from the two trenches, B D, for instance, toward the lower point, I I; that part of it which is not absorbed and assimilated by the roots of the growing plant, gradually sinks into the ground and mingles with the ground-water, and finds its way into the neighboring streams, either by gravity directly through the soil, or by the deep pipe-drains.

Fig. II represents a modification of the process, which is admirably adapted to mild climates, as in England. The flow of the sewage can be readily limited to any particular area by means of the jointed half-pipes B, which can readily be turned in their places with the foot.

Location of Sewage-Farms.

The testimony of two distinguished English authorities before a parliamentary committee, that sewage-farms are "pestiferous swamps," added to the experience of bad smells from the flooded and ill-managed meadows near Edinburgh, led people, naturally enough, to think that irrigation with sewage should be carried on only at points remote from human dwellings. But it was soon found that all sewage-farms were not nuisances; and careful investigations in France, Germany and England have failed to bring to light a single case of injury to health, or of offence arising from sewage-irrigation properly conducted. The First Rivers Pollution Commission say in their final report: "When foul smells are complained of as coming from sewage-irrigated lands, the causes are in the state of the sewage, or in the rude way of using it."

At this time, objection is seldom made to having sewage-farms one mile from towns. At Croydon, six years after irrigation began, land in the immediate vicinity of the farm had increased in value from £250 to £1,000 per acre. This could not have been the case if the farm had been a serious drawback to living in that neighborhood.

Public institutions in England often irrigate with sewage land a few rods from their walls. The high price of land in the immediate vicinity of cities makes it necessary to go four

ıve miles; and that is the distance at which sewa usually found.

Amount of Land Necessary.

Ir. W. Hope, of Breton's Farm, Romford, st ınnual application of five thousand tons to the a best practical results from sewage-farming. Tl ıbout one acre of land to each one hundred ind estimate concurred in by the Sewage of Towns ı. The Rivers Pollution Commission prefer on ry one hundred and fifty people. The Earl of V vever, who has one of the most successful farms l, has one acre of land for every sixty people.

)f course the amount will depend somewhat upon er of the soil and the climate. In Dantzic, on r sand is deemed sufficient to purify the sewa ıdred people. In Berlin, the result of ten years' i ı is that seven hundred and fifty acres will be suf r whole population of 750,000. On the Cra ıdows near Edinburgh, from 20,000 to 100,00 vage are flooded on an acre of land each year, ma lly in some places a swamp over which cattle can hout sinking.

The Effect of Climate.

n England, Scotland and France, no difficulty is gating throughout the winter. The sewage soak , and the effluent is nearly as pure as in summ d, however, is ploughed in the spring, sown w eal, and not irrigated during the following sum colder climate of Berlin, where the ground s ezes to a depth of three feet, some difficulty was e experiments have shown that irrigation will be s year through. In winter the sewage keeps warı ler ice and snow to soak into the ground and bec . Its purification is not as complete as in sun icient to allow it to be discharged into the riv ntzic, where the climate is quite similar to that c setts, sewage-irrigation has been interrupted ter by the cold, and then for only a few days at

climates, of course, sewage-irrigation is more suc-
an in moist.

Theory of the Purification of Sewage.

ion of vegetation is the chief element in purifying
y irrigation, although this is supplemented by a cer-
int of filtration and oxidation by the soil.

thought that all matter must be in a soluble form to
lated by the roots of plants; but later investigators
ne to different conclusions.

in his "Lehrbuch der Agriculturchemie," published
states that rootlets themselves have the power * of
ng substances which are insoluble. He also quotes
Taddei and Mulder, in support of his theory.

i and Taddei found that coagulated albumen in suspen-
ater rapidly disappeared when the roots of a growing
e placed in it, leaving a clear fluid; without the
of the plant it remained turbid.

annel reported to the *Académie des Sciences*, in
ilar results from exhaustive experiments with water
g vegetable and animal matter in suspension. He
acerated fruit in water; and when the mixture had
horoughly turbid and putrid, he divided it into two
at in which the roots of growing plants were placed
ame clear, while the others did not. The same evi-
s obtained by using putrid meat.

fred Carpenter has verified these experiments by a
nd thorough series of investigations.†

eory seems well grounded, and, if proved true, is an
l argument in favor of sewage-irrigation.

The Effluent from Sewage-Farms.

ater, as it passes off from sewage-farms, is often so
not to reveal any evidence of contamination to the
On some farms it runs into brooks from which the

aktive Fähigkeit ungelöste Substanzen, die mit den feinsten
zweigungen in unmittelbare Berührung kommen, in Lösung
en und in sich aufzunehmen."

Power of the Soil, Air and Vegetation to Purify Sewage. [Sani-
d, May 1 and 8, 1875.]

cattle and horses drink, and in many cases it has b
freely by workmen and others for years without
effect. It is the only effluent which comes up to the
required by the Rivers Pollution Commission of
By this rule, no water is allowed to run into stre
contains, for every 100,000 parts, more than two
organic carbon and three-tenths of one part of orga
gen in solution, and in suspension three parts of
matter, and one part of organic matter.

Of course, sewage-farms may be, and undoubted
times are, so badly managed that this degree of pu
is not attained. In no case is it entirely safe to dri
which has once been contaminated with human exc
taining the "germs" of disease, unless it has been e
a sufficiently high temperature, or has stood long e
these "germs" to become inert. How long this ti
be, we do not yet know.

Alleged Ill-Effects.

It is worth while to consider this subject somewha
Drs. Cobbold and Letheby at one time thought that
of parasitic disease in cattle was great, if they we
sewaged grass. That fear has proved groundless.
has been examined, microscopically and otherwise
Hope's farm, and found to be uninjured. The milk
ter from cows fed on sewaged grass have been used
old and young for many years without a single case
from it.

In 1873, Mr. Smee wrote to the "London Times
his farm cows fed on sewaged grass gave bad-tasting
that butter made from it soon became rancid. Mr.
than whom no one is more qualified to give an opi
that these ill-effects probably came from the fact tha
was allowed to lie several days to a considerable d
the grass. He also said that, in all his experienc
never known a single such case on a well-conducted

* It is a well-known fact that soil sodden with simple wate
root-crops which are far from palatable. In one case, near Bo
field received the sewage from two cesspools, and the potatoes r
were even offensive to smell and taste when prepared for the tab

illips, superintendent of the Devon County Insane
said that his cows were fed almost wholly on grass
by the sewage of the eight hundred inmates of his
n; that they gave excellent milk, from which the
utter was made.
ale, director of one of the industrial schools, added
nony as follows: The sixteen hundred residents in
l had for four years used milk and butter freely, with
esults; the cows from which they got their supplies
chiefly on sewage-grown grass. Formerly, when
ge was allowed to collect in the fields, and so became
and putrid, his experience had been different.
fred Carpenter states that he has used such milk
his own house, and has watched its effect carefully
on, where the processes are conducted with care.
ever seen any bad results.
timony is overwhelming on this point.
es of illness have been traced to emanations from
red sewage-farms. Even in Edinburgh, where they
essly managed and foul-smelling, this has been the
n fact, during the cholera-epidemics of 1859 and
region enjoyed complete immunity from the disease.
nly authentic case of illness, probably caused by
rigation, was reported by Dr. T. S. Clouston, in
ical Times and Gazette," June, 1865. He shows that
vere, and some fatal, cases of dysentery had, prob-
n caused in the Cumberland and Westmoreland
by emanations from a sewage-irrigated plot of land,
dred and fifty yards from the wards, with a stiff clay
not underdrained. The method of irrigation, how-
not, in all respects, satisfactory.

The Cost of Irrigation.

-farms have thus far seldom proved remunerative,
any reasons.
essive and fallacious estimates of the value of sew-
o the construction of costly works, so that the
n the money invested was very great.
rmous rents have often been required by landown-
n sixty or seventy dollars a year for a single acre

of land. Land has often been bought, too, at prices ($2,500 to $5,000 an acre), that no farming carried on with profit upon it.

3. The high position of many sewage-farms, and acter of the soil, have often required great outlays ing-apparatus, grading, etc.

4. The necessity of *purifying* the sewage, at creates the necessity of using it at times when it c efit, and must even harm, the crops.

5. The uncertainty due to the amount of rainfa sufficient to turn a profitable use of sewage on lan loss.

6. Sewage-farms have been usually managed boards. If an ordinary farm were to be managed the result would, undoubtedly, be the same.

The Earl of Warwick has, at Leamington, an conducted sewage-farm, one of the few in England carried on by private enterprise. He pays £450 the sewage from a population of 20,000; and it i agreed that his investment has proved a good one.

Except under favorable natural conditions, s account of its extreme dilution, is expensive to h is of little value as compared with other fertili sewage of most English cities is so diluted, that o Peruvian guano has the same value as 1,250 tons In American cities, where twice as much water i value would be only one-half as great. Water, h one of the best of disinfectants, and a copious sewage is necessary to the health of the inhabitan ulous districts. The pecuniary sacrifice, if any, e such dilution, must of necessity be endured.

At Dantzic, where all of the sewage of the city irrigation, the amount of water used in flushing makes the total amount carried off about as great a in American cities. At Munich, where irrigation probability, finally be used, the amount of wate flushing the sewers alone, amounts to 100 gallo individual of the population, at each flushing.

In England, however, a few towns have intro separate system of sewers, so as to have their sew

as possible, before using it in irrigation; but it is
whether the advantage gained may not be more than
anced by the evils arising from imperfectly-flushed

investigators, and especially Varrentrapp, have
at the mercantile aspect of the question must be
nd that purification of sewage must be rendered
on sanitary grounds alone, whatever the cost.

METHODS OF DISPOSING OF SEWAGE.

Manchester, England.

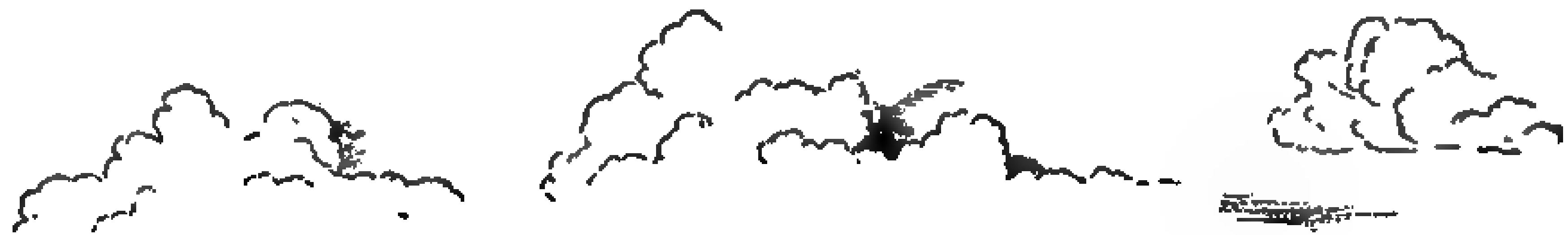
population of 356,600, living on 4,516 acres, a very
ortion of them being of the improvident class, this
d until quite lately to the cesspool-system, dis-
s surface-drainage and kitchen-waste into the rivers
and Medlock, which became filthy to the last
About 50,000 of the inhabitants, including those at
now supplied with water-closets, and from these
scharge is into the rivers. The better classes live
ost part outside of the city limits; but, whether
without, they insist upon having water-closets in
es.

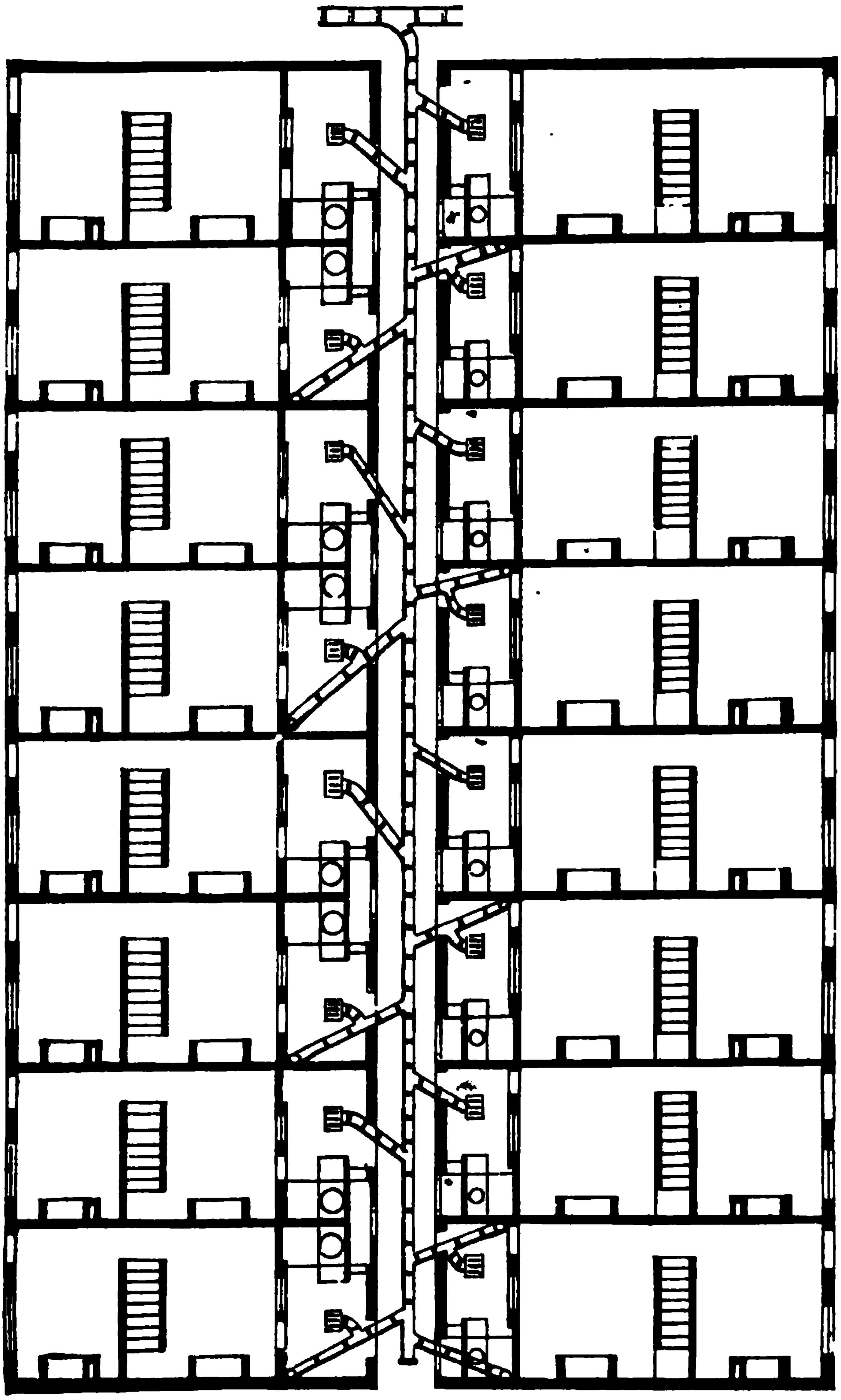
ain hope of keeping the sewage pure enough to
into the rivers, the Health Committees have been
cesspools,* and substituting the pail and cinder-
ies already described.† These ash-pits are very
y where the water-carriage system is not practicable,
thod of emptying them is costly, and not entirely
fence. One hundred carts are constantly employed
ester, removing a mass of ashes and excrement,
some high theoretical value. It is piled up just at
f the city, and in winter sells rapidly for a shilling
a ton. In summer the farmers give only a penny

nd 1873, 4,000 cesspools were emptied, the black and saturated
th was removed, and the cavities filled with clean earth. This
ld always be followed in getting rid of these nuisances. In
and private buildings, buried and concealed filth finds one
another for its poisonous gases, whenever the attempt has been
the smell out by closing one escape-hole after another. It is
iment of nailing down the safety-valve of a boiler.

182. Fifteen thousand have already been introduced.

Fig. II.





Plan showing Privies (Ash-Closets) and Sewers, Manchester, England.

e-manure.
e guano (from A. B. C.-process).
vian guano.
e manure (mixture of No. 2 and night-soil).
ge-mud.
t-sweepings.

esults do not correspond with those obtained in ssels, Berlin, and by the various royal commissions ; but cartage, in this case, amounted to nothing, was close to the works. If the precipitate is so is difficult to see why the farmers do not buy it. cess of precipitation is as follows: The sewage ly through six iron tanks in succession, each fifty and ten feet deep. A deposit takes place in all of is removed when it become a foot deep. The it passes from the tanks, is somewhat turbid, and agreeable odor; but it soon putrefies. Preparations for using it in irrigating large beds of osiers so as before final discharge into the river, which is now that it is difficult to distinguish the water, by its , from fresh sewage. There is no offensive smell* vorks, near the pumps or elsewhere, except from precipitate.

ginal cost of the works, exclusive of sewers, was of which the annual interest would be £3,200. outlay is £15,000. The annual income, suppose manure found a sale at two shillings a ton (which) would be only £7,300, showing an annual deficit).

Birmingham.

g the provisions of the Public Health Act of 1848, xpended £200,000 in constructing sewers with their o the rivers Rae and Tame, one of which is six feet her twelve feet wide. In 1858 the pollution had great that a chancery injunction was served upon prevent the continuance of the evil.

ncil then proceeded to build two sets of tanks, each

age is delivered fresh. The sewers, 120 miles in length, have penings into the streets for ventilation.

being 360 feet long, 90 feet broad and 6 fee
:h the bulk of the matters in suspension in t
deposited, and there were thus arrested about
ls of slush a day. The effect on the river is de
erman Osborne as follows :—

The sewage of the borough is discharged into
ıe, but subject to some slight purification ;
ion of the solid matter is removed, but scarc
which is held in solution, so that a very large
he latter passes off into the river, and in a s
ing with the temperature, undergoes decompo
uting the stream."

ı 1866 and 1867, complaints were again made
he river, and it was decided to try the effect of
rtion of the sewage on about 130 acres of land
rrigation. This was so far successful that it
ed to recommend the council to take the sev
t miles from its present outlet, and to purify
ıe same way on 2,500 acres of land. This wa
n account of the high price demanded by the
land, and another committee decided upon t
s for intermittent downward filtration, combine
on. This was approved by the council, and
oduced into the House of Commons, which wa
hree votes on the third reading.

ı the meantime the sewage-precipitate was a
in such vast quantities that it became itself a
another injunction was obtained.

hat is to say; the city, in accordance with an A
ent, built sewers, was compelled to introdu
ets, and was advised to discharge its filth into
enient stream. It was then compelled by ch
tion, under a later Act of parliament, to keep i
ıe stream. While using the best practicable r
g this, it was served with another injunction to
ance created in the very process of removing t

Defeated in parliament in its attempt to obta
vage farm, which was the method recommend
satisfactory one for purifying sewage, by all

s appointed to investigate the subject, it was diffi-
w what to do.

hen decided to clarify the sewage by the lime-
ing twelve tons of lime a day. Accordingly, four
sets of tanks were built, of four compartments
cost, including engine, etc., of £70,000. These
ks are each 150 feet long, 50 feet wide and 6 deep.
l outlay, exclusive of interest on the capital in-
s, in 1874, £13,000; this year it has probably
. The precipitate to be disposed of daily is 350
is, and it sells for a trifle over a shilling a ton
lings for a boat-load of twenty-five tons). Only
ntity, however, can be disposed of at that price.

le sewage of the city is now treated at the works
erent methods.

le irrigation with the raw sewage. One hundred
acres, all that can be got, are irrigated with a small
the sewage. The land is underdrained at a depth
t, and the effluent is so pure as to be freely used
kmen for drinking. The main and lateral sewage-
re shallow trenches dug in the earth. The vege-
ed are sold freely in the market, and there is said
rejudice against them, many persons even prefer-
Farmers in the vicinity of the works ask for, and
ee of charge, sewage for irrigating their lands.

ation with the effluent, after it has passed through
tanks for precipitating the suspended matters. It
at turbid in appearance, and is used in precisely
manner and quantity as the unclarified sewage.
er and the farm-hands consider it fully as valuable
; the crops in the two cases look equally well.

e was so great complaint from the offensive odors
drying the precipitate, that much of it is now raised
power, by means of an endless-bucket pump to a
nduit several feet above the ground, whence it is
to various parts of the farm. It is of the consist-
oft mud, and contains eighty per cent. of water.
g distributed over the land, about a foot deep, it is
hand-labor. This process is carried out in each
d, once in three years. It is a costly manure, as

so much labor is required to handle it, but it is sa
prove the land in a high degree.

4. In the first of the series of settling-tanks (
two sets, to be used alternately), the heaviest pa
suspended matter is precipitated by lime. As so
becomes two feet deep, about once in two weeks, th
run off, the tank is closed, the mud is allowed to d
then removed by means of shovels. This process is
with very offensive smells.

5. A portion of the last-named matter is kiln-
made into cement by Scott's process. This is cer
best method of disposing of sewer-sludge at presen
The works at Birmingham are on a small scale,
constructed to show that good cement may be ma
way without great loss. The large amount of in
sewage renders the addition of a large amount of li
sary. Three tons of cement are made each week, a
readily for seven shillings a barrel. The loss, in
operation of converting the sludge into cement, is f
cent.

Nearly 17,000,000 gallons of sewage (dry-weat
are pumped each day by steam and treated with fro
to thirteen tons of lime. The workmen state that
come accustomed in a short time to the bad odor
work in the open air so much of the time that th
good health.

Coventry.

This is a town of 20,000 inhabitants, with a d
weather flow of 800,000 gallons of sewage. The p
ing process now used is one patented by Dr. A
differing only in unimportant details from the metho
have been made the bases of experiments in France,
and Germany. A cheap shale, found in the immedi
borhood, is treated with crude sulphuric acid, by w
phate of alumina is obtained at a low price.

The floating matters in the sewage are remove
ingenious revolving screen, invented by Mr. Baldwin
and worked by the motive-power of the flowing sew
simple grating, cleared occasionally by means of an i
is cheaper, and fully as serviceable.

ge is then mixed with the sulphate of alumina (four
h 1,000,000 gallons) in a large tank, from which
a second tank, where it is again mixed with lime
each 1,000,000 gallons*). Sulphate of lime is
d, setting free the alumina, which is precipitated.
ins of lime pass out in each gallon of effluent.
ks, of two compartments each, are used alternately
; they are each one hundred and fifty feet long,
vide, and ten feet deep, and have a capacity of
llons. After standing about a week, during which
is a constant overflow, the supernatant fluid
is passed off, and the sludge is brushed through
ound passage into the building where it is pumped
by artificial heat under cover; an apparently inof-
costly, process.
n tons of the "manure" are precipitated daily, at
out ten shillings a ton; its commercial value, as
dy, is about two shillings a ton. The company
t a theoretical value of £2 a ton, and is now en-
fortifying" it with other manure, by which addition
will be worth £5.
ent, as passed from the tanks, and before putrefac-
gun, is nearly clear. It does not satisfy the Rivers
Commission, and much of it is purified by irrigation
ing into the river. The stream into which it is
is so polluted from other sources, as to resemble,
nce and smell, a common open sewer.
dom of the works from offensive odors is got at
to the city. The effluent requires purification
n be allowed to run into the river, and the manure,
September, had not found purchasers. The city
company in charge of the works a large subsidy,
g the interest on the original cost of the works.
pany has had nothing to pay towards the construc-
works, and, beside receiving the subsidy from the
es all the revenue from the sale of "manure."
f the works is given.

sand gallons of sewage produce about one ton of precipitate.

Edinburgh.

rigation has been carried on for almost two ce
ıse of brooks, which have been made to conve
of certain parts of the city. There are at pr
s: One, the famous Craigentinny meadows, o
ı, of two hundred and fifty acres, east of Edinb
close to the beach; a second, to the west, on
Burn, of ninety acres; to the south, Jordan
eleven acres; on the northerly boundary o
acres are irrigated by the Broughton Burn.
ll those farms was formerly carried on in the ru
possible. The land was fairly drenched wit
00 to 100,000 tons* being used, in some c
e acre in one year. The effect was, that Edin
rounded by these artificial swamps, which at
odors of not the most agreeable description."
ent time, the method of irrigation pursued is
ed, but still not entirely free from objectionab
ne sewage is distributed by gravitation thr
ches, and is flooded over each lot of land for a
in nine days;‡ it is quickly absorbed, with
source of offensive smells. The main conduits
s, at least, in a foul condition; their sides are e
ir as the level of the sewage falls, and, being s
e earth, and not always thoroughly cleaned, the
e mass of decomposing organic matter.
nly grass§ is raised on on these farms, as it i
which thrives under such neglect, and is at
highly remunerative. Four crops are raised

'ive thousand tons is the amount considered best by Mr. Ho
orities.
eport on the Sanitary Condition of the City of Edinburg
ttlejohn, M. D., F. R. C. S. E., medical officer of health

Iore or less; depending upon the weather.
talian rye-grass, a biennial plant, has proved almost a ne
ge farmer. It is capable of receiving an immense amou
out injury, and is admirably adapted to receive any surpl
ccasions when it is not needed for vegetables and root-c
e plant is given, which I have copied from Fegebeutel.
as been so successful in England, that it has been introdu
Germany on the sewage-farms.

remedied with care. The odors from them were found by the writer, last September, to be offensive, though not intensely so.

West Derby.

Three years ago, the parish of West Derby, adjacent to Liverpool, purposed building sewers, with outlets into the river Mersey, at an estimated cost of £30,000. Being threatened with an injunction, they decided to carry their mains farther, buy a farm, and irrigate. The cost has been as follows:—

For construction of sewers, ...	£42,335
two hundred acres of land, ...	34,000
levelling, constructing conduits, purchase of stock, etc., ...	24,000
tanks (estimated), ...	4,000

The running expenses are estimated at £3,000 a year. The crops find a ready sale, and it is thought that, under good management, they will yield an annual income of £4,000.

As far as sanitary requirements and engineering skill are concerned, the farm is a model one. It was laid out by Mr. W. Hope. The land was rather heavy and rough, and large sums were necessarily spent in its preparation. Drainage-pipes are laid at a depth of four feet and a half, and twelve feet apart. The sewage is distributed by gravitation through open cement carriers, and from them by shallow trenches dug in the earth. The latter are thirty feet apart. The land is graded from the mains so as to have a fall of one in 150.

The sewage, purified by the vegetation and the action of the soil, mingles with the ground-water, and passes out through the drains, a clear, sparkling stream, into the river Alt. Large settling-tanks are in process of construction, partly to serve as reservoirs over Sundays, and partly to deposit the solid matters, which are considered of little value. There is a difference of opinion as to the utility of these tanks. So far as the sewage is thereby retained long enough for putrefaction to begin, by just so much is its value lessened.

Carrots, turnips, beets, grass, rye-grass, etc., are raised on the land irrigated during summer. The plots which are used

in winter-irrigation are planted in cereals, and are not irrigated during the warm months. Seven crops of rye-grass are raised each year, the first being cut in January, the last in December.

The land has increased in value, much of it that was very poor now yielding good crops.

There is no complaint of bad odors, and in August it was found absolutely free from anything of the kind. There is a slight fresh-sewage smell close to the conduits.

The main carriers for the sewage are of cement, as represented in Fig. I, page 340 of this Report; the laterals are shallow trenches in the earth, and from each two contiguous branches the land is so graded as to slope gradually to the central point between them, at a fall of about one in fifty.

Crewe.

The farm, two miles distant from the town, disposes of the sewage of 25,000 people on 300 acres. It was admirably laid out by Mr. Hope, and is well managed and free from offensive odors. The sewage is pumped before distribution, and the annual deficit in the account is a considerable one. The crops are sold readily. The produce of a single acre of oats sold, late in August, for £20, at auction. The soil is of the toughest clay; much of it required burning before crops could be raised on it to advantage. The subsoil-drains are four feet deep, but experience has shown that the sewage runs off too rapidly, and that it would be better, in such a soil, to place them two feet deeper still. Mr. Hope has here shown that any soil whatever may be made capable of purifying sewage by irrigation.

Romford.

This farm was visited, in 1870, by Dr. Bowditch, and was found absolutely free from offensive odors. The same fine crops which he observed are still found there. "Carrots, four and a half inches in diameter, and a foot long; mangolds, twenty-nine and thirty-six inches in diameter, and pressing up, like huge monsters, from the ground; cabbages, huge and compact; immense beds of rich and firm cauliflowers; potatoes, eight or nine inches long, and weighing, at times, two

pounds; hay of delicate fibre, and eagerly sough
cattle, can be raised in three crops annually, and, in
five acres produced as much as twenty-five treate
usual former method." *

Mr. Hope has given his personal attention to
here, and the results have been eminently satisf
every way, except that they have not been profita
considers this fact to be due to causes which can be
The scientific experiments, of great value, which h
conducted here, are to be found in the proceedin
British Association for the Advancement of Scienc
last seven years. In three years about 168,000 p
nitrogen were distributed on the farm, of which it
mated that nearly 58,200 pounds, or 34.6 per ce
recovered in the crops; of the remainder, some escap
effluent water, chiefly in the form of nitrates and nit
some were stored in the soil.

The following tables (see pp. 360–372) are quo
the sixth report of the committee on the treatment
zation of sewage † at the meeting of the association
as they are of great practical interest.

Croydon.

Under the Public Health Act of 1848, the auth
Croydon built extensive sewers, and connected wat
with them, as the law compelled them to do. As
Wandle, into which they discharged their sewage,
brook, ankle-deep in some places in summer, it soo
so polluted as to give occasion to frequent complain
various deodorizers, precipitants, etc., were then t
proved to be failures. At last, irrigation was beg
experimental way, as there was absolutely no expe
any part of the world to serve as a guide. ‡

In 1853 there was such a violent outbreak of f

* Second Report of the State Board of Health, p. 241.

† This committee consisted of Richard B. Grantham, C. E., F.
man; F. J. Bramwell, C. E., F. R. S.; Prof. W. H. Corfield, M
(Oxon.); J. H. Gilbert, Ph. D., F. R. S., F. C. S.; W. Hope, V. C
W. Williamson, Ph. D., F. R. S., F. C. S.

‡ Even then the irrigation at Edinburgh was not considered s
from a sanitary point of view.

vestigation by parliamentary commissions.* The
as found to be due to defective sanitary arrange-
which, the sewer-gases escaped into the houses.
ulty was remedied,† and the town was unusually
disease until the epidemic of 1875, which was due
lution of drinking-water by sewer-gases, as already
‡
the town was compelled by chancery-injunction to
sewage so as not to make a common sewer of the
dle, the first attempts at irrigation were attended
y failures, and at times a nuisance was probably
Experience has, however, remedied all these defects;
s free from odors, and there has not been a single
for several years, although there are many people
he immediate vicinity, and the public road passes
rough the farm. Six houses, each renting at from
£150 a year, have been built within a few rods of
ted land. A large orphan asylum is close to one
; and, a fourth of a mile distant, twenty-five cot-
s been built. In all these places, typhoid fever is
known. The workmen and the occupants of the
se, by preference, the purified sewage for domestic
§ It looks clear and sparkling,‖ has no especial
e than satisfies the conditions of the Rivers Pollu-
nission, and the brook into which it runs is literally
minute fish. The water is so clear and free from
ve ingredients, that a wealthy gentleman, living near
uilt a conduit, at his own expense, to have it con-
ough his grounds.
the land was originally bought for £160 an acre;

ports were published: 1. By T. Southwood Smith, M. D., and
land, M. D. 2. By R. D. Grainger and Henry Austin. 3. By Neil
D., and Thomas Page, C. E. 4. By Henry Austin, Consulting
the General Board of Health. 5. By Thomas Wicksteed, C. E.
as no evidence that the irrigation with sewage was even partly
f the outbreak.
e 293.
e this use of the water is not recommended by the health author-
harm has been known to come from it at Croydon.
e of it, kept for a year by Dr. Carpenter, remained clear and
he effluent from the sewage-farm at Aldershot is also extensively
nking, and is preferred to any other that can be got.

[See p. 373.

TABLE I.—*Breton's Sewage-Farm. Statement showing Crops grown from March 25, 1873, to March 24, 1874.*

	No. of beds (inclusive).	Acreage.	Crop.	Date when sown or planted.	Date when cut or gathered.	Produce. Total—tons.	Produce. Per acre—tons.	Remarks.
Plot A,	1 to 29, .	9.8	Cabbage, . . .	Oct., 1872, .	April to June, 1873.	124.74	12.7	
	1 to 29, .	9.8	Barley, . . .	June, 1873, .	Oct., 1873, .	13.52	1.4	Including 6.94 tons straw.
	1 to 29, .	9.8	Italian rye-grass, .	" 1873, .	Dec., 1873, and Jan., 1874.	32.63	3.3	Sown the day after the barley; once cut.
Total, .	. . .	9.8	. . . . . .	. . . . .	. . . . .	170.89	17.4	The whole plot under crop at the end of the year. (Italian rye-grass.)
Plot B,	8 to 16, .	4.20	Cabbage, . . .	Sept., 1872, .	May to July, 1873.	92 92	22.1	One-third consumed by cattle, waste, &c.
	1 to 5, .	2.43	Oats, . . .	Mar., 1873, .	Aug., 1873, .	6.58	2.7	4.33 tons straw.
	6 to 7, .	.96	Wheat, . . .	" 1873, .	" 1873,	15.44	2.8	9.54 tons straw.
	17 to 26, .	4.54	Wheat, . . .	" 1873, .	" 1873,			
	1 to 3, .	1.47	Sprouting broccoli, .	Aug., 1873, .	Mar., 1874, .	5.52	3.8	One-third ploughed in or consumed by cattle.

	1 to 16,	6.09	Wheat, . . .	Feb., 1874, .	–	–	–	Crop remains.
	17, 18,	.58	Cabbage, . .	Nov., 1873, .	–	–	–	Crop remains.
Total, .	. . .	6.67	. . . . .	. . . .	. . . . .	64.99	9.7	Plot all under crop at end of year.
Plot K,	All, . .	4.44	Italian rye-grass, .	Sept., 1872, .	Mar., 1873, to Jan., 1874.	277.06	62.4	Crop remains; cut eight times in year.
Plot L,	Part, . .	1.22	Mangolds, . .	July, 1873, .	Nov., 1873, .	25.05	20.5	
	Part, . .	.66	Hardy greens, .	" 1873, .	Dec., 1873, .	3.23	4.9	
	Part, . .	1.00	Savoys, . . .	" 1873, .	Feb., 1874, .	4.38	4.4	
Total, .	. . .	[illegible]	. . . . .	. . . .	. . . . .	[illegible]	11.4	Plot all fallow at end of year.
Plot M,	All, . .	3.17	Italian rye-grass, .	Sept., 1872, .	Mar., 1873, to Jan., 1874.	182.49	57.5	Crop remains; cut eight times in year.
Plot N,	1 to 16, .	4.15	Italian rye-grass, .	Mar. and May, 1872.	Mar. to May, 1873.	140.96	34.0	Grass ploughed in May, 1873.

TABLE I.—*Breton's Sewage-Farm*—Continued.

	No. of beds (inclusive).	Acreage.	Crop.	Date when sown or planted.	Date when cut or gathered.	Produce. Total—tons.	Produce. Per acre—tons.	Remarks.
Plot N,	1 to 16,	4.15	Barley,	June, 1873,	Sept., 1873,	4.74	1.1	Including straw, 3.47 tons.
	1 to 16,	4.15	Italian rye-grass,	" 1873,	Nov., 1873, to Mar., 1874.	26.74	6.4	This grass was set with the barley, and still remains.
Total,	. . .	4.15	. . .	. . .	. . .	172.44	41.5	Plot all under crop at end of year.
Plot O,	All,	5.92	Cabbage,	Sept., 1872,	Apr. to June, 1873.	85.89	14.5	
	1 to 8, 10 to 17,	5.55	Hardy greens,	July, 1873,	Oct. to Dec., 1873.	[illegible]	12.6	
	9,	.37	Cabbage-plants,	" 1873,	Aug. and Sept., 1873.	[illegible]	[illegible]	Transplanted.
	9,	.37	Hardy greens,	Oct., 1873,	Jan., 1874,	.71	1.9	
	1 to 17,	5.92	Onions,	Mar., 1874,	–	–	–	Crop remains.
Total,	. . .	5.92	. . .	. . .	. . .	158.79	26.8	Plot all under crop at end of year.
Plot P,	All,	3.60	Wheat,	Mar., 1873,	Aug., 1873,	8.68	2.5	6.07 tons straw.

Total, .	. . .	2.34	. . . . .	. . .	. . . .	[illegible]	18.1	Plot all under crop at end of year.
Plot R,	Part, . .	2.40	Mangolds, . .	Apr., 1873, .	Oct. and Nov., 1873.	45.32	18.8	
	Part, . .	2.40	Wheat, . . .	Feb., 1874, .	–	–	–	Crop remains.
	Part, . .	.12	Oziers, . . .	Jan., 1873,	Cleared Nov., 1873.	.50	4.1	Oziers used for bunch'g greens, etc.
Total, .	. . .	2.52	. . . . .	. . .	. . . .	45.82	18.2	Plot nearly all under crop at end of year.
Plot S,	All, . .	.22	Rhubarb, . .	Feb., 1873, .	Feb. and Mar., 1874.	.17	.8	Crop remains.
Plot U,	All, . .	2.53	Wheat, . . .	Mar., 1873, .	Aug., 1873, .	7.05	2.8	4.62 tons straw.
	All, . .	[illegible]	Hardy greens, .	Aug., 1873, .	Jan. and Feb., 1874.	5.62	2.2	
	All, . .	2.53	Wheat, . . .	Feb., 1874, .	–	–	–	Crop remains.
Total, .	. . .	2.53	. . . . .	. . . .	. . . .	12.67	5.0	Plot all under crop at end of [year.

TABLE I.—*Breton's Sewage-Farm*—Continued.

	No. of beds (inclusive).	Acreage.	Crop.	Date when sown or planted.	Date when cut or gathered.	Produce.		Remarks.
						Total—tons.	Per acre—tons.	
Plot V,	Part, . .	2.93	Cabbage, . .	Oct., 1872, .	May to July, 1873.	58.48	20.0	
	Part, . .	3.00	Scarlet beans, . .	May, 1873, .	Aug. and Sept., 1873.	.50	.2	This crop was nearly all destroyed by an accident with the sewage.
	All, . .	5.93	Wheat, . . .	Mar., 1874, .	–	–	–	Crop remains.
Total, .	. . .	5.93	. . . . .	. . . .	. . . .	58.98	9.9	Plot all under spring-wheat at end of year.
Plot W,	All, . .	2.75	Wheat, . . .	Mar., 1873, .	Aug., 1873, .	6.61	2.4	Straw, 4.62 tons.
	All, . .	2.75	Hardy greens, .	Sept. and Oct., 1873.	Feb. to Mar., 1874.	5.12	1.9	
	All, . .	2.75	Wheat, . . .	Mar., 1874, .	–	–	–	Crop remains.
Total, .	. . .	2.75	. . . . .	. . . .	. . . .	11.73	4.3	Plot all under spring-wheat at end of year.

computed

NOTE.—The boundaries of plots Q and V have been rearranged since last year.

BLE II.—*Breton's Sewage-Farm. Season 1873–74.*
of Cropping Return.

d.	Acreage.	Crops.	T
,	9.80	Cabbage, barley, and Italian rye-grass, .	1
	12.12	Cabbage, oats, wheat, sprouting broccoli, Brussels sprouts, peas, cabbage-plants, and turnips.	1
,	1.97	Wheat, ...	
,	6.93	Italian rye-grass, ...	4
,	5.76	Cabbage, cauliflowers, sprouting broccoli, onions, lettuce, cabbage-plants, and mangolds.	1
,	3.82	Strawberries, oats, barley, and cabbage, .	
,	5.17	Cabbage, carrots, onions, hardy green plants, spinach, mangolds, turnips, sprouting broccoli, lettuce, and hardy greens.	1
l,	6.40	Onions, hardy green plants, French beans, cabbage, hardy greens, and spinach.	
,	6.67	Onions, carrots, savoys, and cabbage, .	
,	4.44	Italian rye-grass, ...	2
,	2.88	Mangolds, hardy greens, and savoys, .	
l,	3.17	Italian rye-grass, ...	1
l,	4.15	Italian rye-grass and barley, . . .	1
,	5.92	Cabbage, hardy greens, and cabbage-plants,	1
,	3.50	Wheat and hardy greens, ...	
,	2.34	Cabbage and mangolds, ...	
,	2.52	Mangolds and oziers, ...	
,	.22	Rhubarb, ...	
,	2.53	Wheat and hardy greens, ...	
,	5.93	Cabbage and scarlet beans, . . .	
,	2.75	Wheat and hardy greens, ...	
,	3.86	Wheat, ...	
,	5.60	Hay and meadow-grass, ...	
	108.45		2,3

—Breton's Sewage-Farm. Summary of Crops gathered ch 25, 1873, to March 24, 1874, showing the quantity nd of Produce and Nitrogen contained therein.

	Total Acreage of each description of Crop.	Produce of each Crop.		Nitrogen estimated in Crops.		
		Total tons.	Tons per Acre.	Per cent.	Total lbs.	Per acre. lbs.
	28.49	1,112.83	39.1	0.54	13,461	472
w,	5.60	60.00	10.7	0.54	726	130
.		15.50	2.8	2.00	694	[illegible]
.	0.12	0.50	4.1	–	–	–
.	43.85	620.02	14.1	0.25	3,472	79
s, .	17.55	117.00	6.7	0.25	655	37
.	3.29	30.68	9.3	0.25	172	52
'ts,	0.97	0.75	0.8	0.25	4	4.1
.	3.12	[illegible]	5.4	0.25	94	30
.	0.24	1.25	5.2	0.25	7	29
ch r),	4.53	3.02*	0.7*	0.375	25	5.5
.	1.40	10.94	7.8	0.25	61	44
.	0.44	.27† 1.00‡	.6 2.3	3.40 0.80	[illegible]	141
.	3.44	23.67	6.9	0.20	106	31
.	1.86	[illegible]	21.5	0.18	161	[illegible]
.	0.24	2.62	10.9	0.25	15	63
.	9.00	164.72	18.3	0.25	922	102
.	6.00	47.41	7.9	0.22	294	39
.	3.70	4.05§ 7.22‡	1.1 1.9	2.0 0.6	[illegible]	75
.	15.01	8.83§ 12.14‡	0.6 0.8	1.6 0.5	452	30
.	20.11	17.33§ 34.68‡	0.8 1.7	1.8 0.6	1,165	58
. .	1.48	0.09	0.06	0.1	–	–
.	0.22	0.17	0.8	–	–	–
.	170.66	2,353.43	13.8	–	22,766	133.4

y all destroyed by accident. † Peas. ‡ Straw. § Grain.

TABLE IV.—*Breton's Sewage-Farm. Statement of L*
and Land lying Fallow on March 24, 187

PLOT.	Acreage.	Area in Crop, acres.	Area fallow, acres.	PLOT.	Acreage.
A, . .	9.80	9.80	–	N, . .	4.15
B, . .	12.12	7.32	4.80	O, . .	5.92
C, . .	1.97	1.97	–	P, . .	3.50
D, . .	6.93	–	6.93	Q, . .	2.34
E, . .	5.76	5.76	–	R, . .	2.52
F, . .	3.82	2.97	.85	S, . .	.22
G, . .	5.17	2.35	2.82	U, . .	2.53
H, . .	6.40	5.32	1.08	V, . .	5.93
I, . .	6.67	6.67	–	W, . .	2.75
K, . .	4.44	4.44	–	X, . .	3.86
L, . .	2.87	–	2.87	Y, . .	5.60
M, . .	3.17	3.17	–	Total, .	108.44

Comparison.

DATE.	In Crop, acres.	Fallow, ac
March 24, 1872, ...	40.49	63.3
" 24, 1873, ...	87.62*	19.9
" 24, 1874, ...	89.09*	19.3

* In regard to this comparison, it should be stated that the area describ
comprises land sown with spring-wheat.

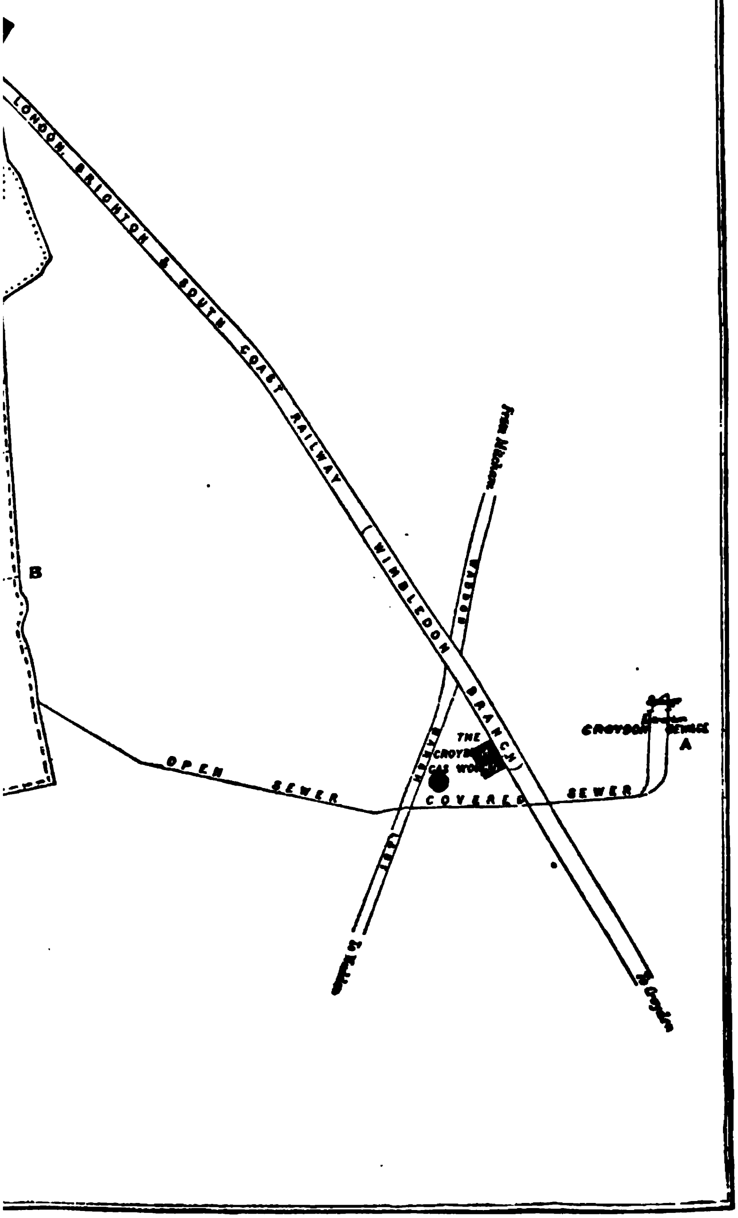
On March 24, 1873, about . . . .
" 24, 1874, " . . . .

There was no wheat in on March 24, 1872. The spring wheat being sow
figures should be borne in mind in comparing the above.

BEDDINGTON, SURREY.

PLAN OF CROYDON SEWAGE FARM,

1875.



t is leased at from £10 to £12 an acre, per annum. such circumstances, and considering the fact that the carried on by a corporation and not by an individual, tural to expect that it would not be profitable. The slight, however. Five hundred acres are irrigated by tion, with a daily flow of about 2,000,000 gallons of from a population of 60,000 persons. The subsoil is gravel, so that deep drainage has not been necessary. hole cost of preparing the land for irrigation has been greater than was necessary. The main conduits for wage are simple trenches in the earth. They answer purpose, as they are cleaned frequently.

crops raised look in admirable condition. Some of the hay, turnips, cabbages, etc., are splendid specimens. ops are sold readily. The Italian rye-grass is irrigated m twenty-four to forty-eight hours each week, the veg- not oftener than once in two, or, at times, four or even eks, if the season is wet. If possible, no particular irrigated within a week previous to the time of its harvested. This rule, however, is not always adhered he case of the rye-grass, which apparently has a capac- being irrigated almost constantly for some time, if it is ary to do so in order to get rid of the sewage.

rge part of the great success of this farm is undoubt- ue to the careful attention given to it by Dr. Alfred nter, chairman of the local board; but the small pecun- eficit, in spite of the enormous rent, is due to the fact has been made in large part a dairy and stock farm. nimals look in excellent condition. Beef from cattle nd raised on the farm, and fed with sewage-grown prod- bring the highest prices in the market, while the milk tter find a ready sale.

a long time the storm-water was the great bugbear of e-farms; but the problem has been solved at Croydon eping two large pastures, of twenty-five acres each, are irrigated alternately in case of heavy rains, as so a flow does not injure short grass.

accompanying map shows the main points of interest Croydon farm. The description, kindly furnished by arpenter, was prepared by him for a large party of

scientific men, who visited the farm at his request. The committee of management of the local board, consisting of Dr. Alfred Carpenter, chairman; Mr. J. S. Wright, Mr. Baldwin Latham, C. E., and Mr. Howard Martin, furnished their guests with a luncheon, of which the following is the bill of fare.

Bread and pastry, from wheat grown upon the farm; beef, from a young heifer which had been two years and a half upon the farm; veal, from a calf bred on the farm; vegetables, as salad, etc., grown on the farm; trout, *en Mayonnaise*, obtained from the river Wandle, into which the effluent water passes; confectionery, made with milk, cream, etc., also from the farm.

The party went away satisfied,—

"That a sewage-farm is not a swamp or marsh; that it does not injure the health of a neighborhood; that it does not damage residential property, except from the ideal point of view; that it turns poor land into land capable of producing luxuriant crops; that its produce is beneficial to cattle; that cattle fed upon sewage-produce are themselves healthy; that the food produced is fit for human consumption; that a large farm cannot be farmed successfully, except a large capital be invested in it; that the experience of sewage-irrigation on the same land for fifteen years will justify the capitalist in putting capital into sewage-agriculture, under favorable circumstances."

Dr. Carpenter showed that the death-rates had diminished in the vicinity of the farm (population 2,900). This fact showed, at least, that no influence unfavorable to health existed there.

Description of the Map.

"A is the filter-house, on the site of the old filtering-tanks, which were immense nuisances to the neighborhood. The tanks have been filled up with town-refuse, and have been utilized as garden-plots for men in the employ of the local board. The workmen are allowed to take liquid sewage as they please. The crude sewage, as it comes from the town sewers, passes through one of Latham's Strainers. The extraneous matters which are removed (*i. e.*, lumps of

rags, paper, etc.) are mixed with dry straw and garden- collected from the dust-bins of the town. The com- thus rendered comparatively inoffensive, and is partly n the farm, and partly sold to market-gardeners in the orhood, at 2s. 6d. per yard. The machine is self- the sewage itself being the moving power. About a nd a half of manure is produced every day.

xt is the open sewer, B. At this point the crude sew- sses on to the fields. The sewage is perfectly fresh, three hours being occupied in its transit from the most part of the district to the filter-house. The quantity from three to eight or ten million gallons; the first ty being the dry-weather supply, and the excess being the admission of a portion of the rainfall.

e farm is given in outline on the plan; it consists of 500 acres. That part which can be irrigated is bounded roken black line. There are generally 150 to 200 acres rye-grass cultivation; 50 acres are meadow, and are used for the purpose of cleansing storm-waters; 82 der cultivation for market-garden purposes; the remain- s mangolds, or other roots or cereals.

eld C, now under sewage, which is applied to alternate or twelve hours at a time, more or less, had wheat last and produced six quarters six bushels to the acre, and, he straw, gave a return of £22 3s. 9d. per acre. The as had no other manure than sewage for fifteen years. laid down with rye-grass in the autumn, and was cut first time May 14. The sum received for the cutting 7 per acre. The second crop is now growing. The ext to the wheat was occupied last year with potatoes, roduced £19 per acre. The rye-grass was sown too nd had to be resown this spring. The first cutting d £4 2s. per acre.

e plot was sown with rye-grass in September last; the utting, April 24, produced £7 15s. per acre; the l, now cutting, realizes about £12 per acre. It is sold n 4d. to 1s. 6d. per rod to cowkeepers and others, who or it, and pay for it as they take it away.

e plot E was market-gardened last year, and is now

growing oats (twenty-seven acres). When the oats are taken off, the land will be laid down with rye-grass.

"F* is the strainer for the sewage which comes from Norwood. It is similar in action to that at the filter-works. A portion of the farm near to this filter-house cannot be irrigated. The field is now market-gardened.

"F is laid down with rhubarb; it occupies 2 acres 2 roods, and this year has produced £66 6s. 9d., or £26 10s. 8d. per acre, and will be better next year. The irregular plot numbered 3 on plan has been an uncultivated shaw. It has been grubbed up at an expense of about £14 per acre, and is for the first time planted with potatoes. It has been a dead weight to the farm for years, producing abundance of weeds.

"G: rye-grass for four years was broken up last autumn, and has now a crop of cabbages, with some seed-beds for planting out, upon it.

"H and I are under rye-grass; the first portion sown last September; first cutting April 20; second cutting June 3. A portion weighed from this field, in the presence and for the information of several agriculturists, during the recent show, gave a produce of 15½ tons per acre. This plot consists of —— acres, and has realized this spring £111 13s. 6d. Another portion was resown this spring, was cut April 30, and a second crop is now growing. A portion has been fed off by sheep.

"The hay from rye-grass, when made before the pollen drops from the flowers, is much enjoyed by cattle.

"The outfall will be found at Z. An analysis of the effluent was recently published by the Rural Sanitary Authority, which was made by Dr. Hassall, and which gives the following as the result in 100,000 parts:—

Total hardness,	23.8
Temporary hardness,	15.1
Permanent hardness,	8.7
Total solids,	44.
Nitric acid,	2.15
Free ammonia,	0.0082
Albuminoid ammonia,	0.0297
Chlorine,	3.0442

"The nitric acid may be in the water as harmless nitrates, a large quantity being known to be present in superficial chalk waters. Having to go to the second figure in decimals for the ammonia, appears to be most satisfactory. At the same time, it is not suggested that the effluent water should be ever used for drinking purposes. Analysis made by Dr. Frankland, and taken from the effluent stream without notice, has given a much more favorable result than is given by Dr. Hassall. Near to the outfall is the water-cress bed, and a much larger plot at the south-west corner of the farm. The chairman of the committee on management was not on the board when this larger bed was laid out and let to the grower.

"X is a meadow used principally for storm-water.

"W.—Keeper's gate. Rye-grass, sown in the autumn of 1873, was cut seven times last year, including one cutting which extended into January of this year. It was cut on March 25 of this year, again about May 10, and is now a third time in process of cutting.

"S is now in the hands of the market-garden manager; but Mr. Horsely, the farm-manager, will take possession in the autumn, and lay it down again in rye-grass. It has been cultivated for market-garden crops without other manure than sewage for three years.

"T is a meadow. In it will be found most of the stock belonging to the local board, including calves, yearlings and heifers. All the younger stock has been produced on the farm, and fed entirely on sewage-produce. Other fields, right and left of the road, will be observed under rye-grass or other kinds of cultivation.

"O.—The rye-grass was resown this spring, and the second cutting is now growing.

"P has been broken up this spring, and is preparing for autumn cabbages.

"It is intended to make hay from the second cut upon Q and R.

"I and L are mangolds. A portion of these plots were mangolds last year. About 700 tons were raised on the farm; one-half were consumed by stock on the farm; 350 sold by auction in the spring, and realized 25s. and 26s. per ton.

"K was also mangolds; it is now planted with cabbages, and

when they come off, will be laid down in wheat on a portion of this field. Forty-four tons of long, red mangolds were grown to the acre on portions of this plot."

Bedford.

The accompanying map is illustrative of an admirably-managed farm.* The town has 18,000 inhabitants, the dry-weather flow of sewage is 700,000 gallons a day, and the average annual rainfall is only 21 inches.† The main sewer is about a mile and a half long, and is large enough to serve as a reservoir during the night, and with a storm-overflow into the river, to be used in case of prolonged rain. The flap is self-acting, so that an excessive rainfall during the night will pass off without trouble.

The sewage passes through a simple grating to screen out rags, paper, etc., and is then raised by pumping into a cast-iron tower, twelve feet high and seven feet in diameter, whence it is distributed to the various parts of the farm by gravitation; the three different plots (see map) being of different heights and requiring different degrees of elevation of the sewage.

The sewage is distributed by the pipe-system;‡ there is, therefore, absolutely no odor, and an advantage is thought to be gained in preventing the volatilization of the ammonia.

Onions, carrots, turnips and other vegetables are raised, and the crops look promising. The effluent is clear, and has no disagreeable taste. The river Ouse, into which it runs, is bright and sparkling. In winter the effluent does not attain the same degree of purity as in summer; but still it does not putrefy nor foul the river, and it satisfies, even then, the standard of the Rivers Pollution Commission.

The town owns 27 acres of the land, and leases the re-

* It will be seen that the farm is really divided into three plots. The sewage is delivered by the main conduit to the pump, whence it is raised to a sufficient height in the stand-pipe to allow of its being distributed over the farm by gravitation. The positions of the main carriers, covered by an embankment of earth are given, with their sizes. The lateral sewage-carriers are simply trenches in the earth. The positions of the cart-roads are also given.

† About one-half as great as in most parts of Massachusetts.

‡ See Fig. II., page 340.

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mainder, 155 acres. There has been no extravagent expenditure, and the receipts, since operations began, August 18, 1868, show only a very slight loss. From August 18, 1868, to December 31, 1871, there was a deficit of £1,106 7s., which was to have been expected in the beginning. In the year 1874 there was a profit of £180 15s. 4d.

The following accounts, for which, with the map, I am indebted to Mr. John Lund, borough surveyor, will be found of interest:—

Bedford Local Board.

Statement showing Total Expenditure in respect of Sewerage, Water, Embankment, and Irrigation-Works, up to 31st December, 1871, from August 18, 1868.

Sewerage-Works.

L. B. Moore, Contract No. 1,	£17,083	15*s.*	7*d.*
" " loss caused by floods,	200	0	0
" " extra work,	18	10	0
Ventilating grates, man-hole covers, lamp-hole covers and castings,	786	4	10
Compensation for injury by works,	356	13	4
Extension of main to Britannia road and Muswell road,	185	5	1
Miscellaneous expenses,	106	9	1
	£18,736	17*s.*	11*d.*

Water-Works.

Contract A, steam-engines,	£1,950	6*s.*	0*d.*
" B, cast-iron pipes,	5,091	3	2
" C, sluice-valves and hydrants,	755	3	9
" D, laying mains,	2,510	11	6
" E, Reservoir,	1,710	19	11
" F, engine-house,	2,792	5	10
Purchase of land,	1,230	0	0
Compensation for injury by works,	142	0	0
Sinking wells,	440	3	6
Extra engine, boiler and pumps,	221	9	3
Hire of steam-pumping-engine,	248	7	5
Pipes,	210	17	7
Coal,	84	18	3
Labor,	77	6	7
Miscellaneous expenses,	183	17	5
	£17,649	10*s.*	2*d.*

Irrigation-Works.

Contract A, steam-engines,	£890	18s.	8d.
" No. 2, iron pipes and cylinders,	748	4	4
" No. 3, wall,	136	2	6
" No. 4, engine-house,	442	15	2
Purchase of land,	250	0	0
Compensation for injury by works,	53	1	0
Labor,	1,213	9	1
Pipes,	1,590	9	7
Farm-buildings,	451	11	8
Horse-hire and carting,	331	3	9
Horses, carts and implements,	252	0	9
Coal-shed,	147	16	6
Fixing boiler,	78	18	7
Contract for wells,	57	10	0
Miscellaneous expenses,	352	18	10
	£6,997	0d.	5d.

Embankment-Works.

Total cost,	£2,703	15s.	8d.
Compensation for injury by works,	1,785	0	0
	£4,488	15s.	8d.

General.

Superintendence of works,	£1,091	15s.	4d.
Lawson, Commission,	2,200	0	0
Lithographing specifications, stationery, and advertisements,	138	5	6
Law charges, including costs of solicitors of Provident and Economic Life Offices,	444	17	8
Miscellaneous charges,	1,276	8	0
	£5,151	6	6

Summary.

Sewerage-works,	£18,736	17s.	11d.
Water-works,	17,649	10	2
Irrigation-works,	6,997	0	5
Embankment-works,	4,488	15	8
General,	5,151	6	6
	£53,023	10	8

BEDFORD IRRIGATION-FARM.

Statement of Cost of Pumping the Sewage on the Land, Farming Expenses and Receipts up to 31st December, 1871, from August 18, 1868.

Labor,				£668	4s.	3d.
Salary of manager,				247	16	0
" of engine-driver,				190	19	4
Ploughing and threshing,				22	5	0
Rent, rates, and taxes,				2,029	10	3
General outlay:—						
Coals,	£466	18s.	1d.			
Tradesmen's bills,	69	10	7			
Horse-keep,	286	7	1			
Seeds,	197	5	6			
Insurance,	0	6	0			
				1,020	7	3
				£4,179	2s.	1d.
RECEIPTS.						
Total sales of crops by auctioneer, less commission,	£3,144	17s.	0d.*			
Deduct amount due from Mr. L. J. Ibbs,	248	11	0			
				£2,896	6s.	0d.
Miscellaneous receipts,				176	9	1
				£3,072	15s.	1d.

IRRIGATION-FARM, BEDFORD.

General Account and Balance Sheet at Stock-taking, Dec. 31, 1874.

DR.

Stock, December, 1873,				£431	0s.	0d.
Working-plant, Dec., 1873,				222	4	0
Labor,	£492	9s.	7d.			
Manager,	112	11	1			
Engineer,	62	16	6			
				667	17	2
Tradesmen's bills paid,	£79	11s.	7d.			
Tradesmen's bills owing,	30	10	2			
Coals,	260	2	7			
Coals owing,	32	8	0			
Horse-corn, etc.,	40	8	9			
Manure purchased,	10	0	0			
Horse and bullocks purchased,	133	10	0			
Seeds,	102	8	4			
Amounts carried forward,	£688	19s.	5d.	£1,321	1s.	2d.

* The first sale of crops took place on the 2d of September, 1868.

Amounts brought forward, .	£688	19s.	5d.	£1,321	1d.	2s.
Hire of horses for ploughing, .	30	3	0			
Mr. Stafford's commission and expenses, ...	114	12	6			
	£833	14s.	11d.			
Deduct bills owing, 1873, .	53	4	2	780	10	9
Rents,—						
The Rev. Campion, ...	£126	14s.	11d.			
Captain Polhill-Turner, ...	421	11	3			
Duke of Bedford, ...	244	8	2			
Corporation of Bedford, ...	123	9	8			
L. & N. W. Railway,—sewer under railway, ...	1	0	0	917	4	0
Poor-rates, ...	£92	0s.	6d.			
Income-tax, ...	18	3	2			
Land-tax, ...	3	1	2			
Insurance, ...	0	10	0	113	14	7
Permanent works, ...				24	2	8
Oats, ...				16	5	0
Hay, ...	£48	2s.	6d.			
Beans, ...	59	10	0	107	12	6
Balance for 1874, ...				180	15	4
				£3,461	6s.	0d.

CR.

Sale of crops, ...				£2,515	13s.	10d.
Stock in hand and purchased, 1874,—						
30 tons of hay, £5, ...	£150	0s.	0d.			
26 loads of beans, 28s., ...	38	8	0			
2 acres of mangolds, £20, . .	40	0	0			
6 tons of potatoes, £4, ...	24	0	0			
16 acres of growing wheat, 50s., .	40	0	0			
Bean, barley, and oat straw, . .	15	0	0			
Rye-grass hay, ...	10	0	0			
Pickling-cabbages, ...	12	0	0			
Carrots, ...	25	0	0			
12⅛ qrs. oats, 26s. per qr., . . .	16	5	0			
6 acres of growing cabbage, £5, .	30	0	0			
9½ acres of growing rye-grass, 50s.,	23	15	0			
8 bullocks, £15, ...	120	0	0	544	8	0

Working-plant and live and dead stock,—

4 horses,	£175	0s.	0d.			
3 carts, £8,	24	0	0			
1 horse-roll,	7	10	0			
1 double plough,	3	0	0			
1 single plough,	1	10	0			
1 horse-hoe,	4	0	0			
1 scuffler,	4	0	0			
2 sets of harrows,	2	0	0			
1 pulper,	2	10	0			
1 chaff-cutter,	4	0	0			
1 bean-mill,	2	10	0			
6 wheelbarrows,	1	4	0			
4 sets of harness,	6	0	0			
1 cultivator,	2	15	0			
2 cow-cribs,	3	0	0			
Office furniture,	2	10	0			
Coals in stock,	24	0	0			
				£269	9s.	0d.
Sewage-works,				24	2	8
Hay,	£48	2s.	6d.			
Beans,	59	10	0			
				107	12	6
				£3,461	6s.	0d.

J. E. CUTCLIFFE,
W. ROFF,
HARRY THODY,
THOMAS HALL BARKHAM,
JAS. THOS. HOBSON,
Farming Committee.

The health of the people has not suffered from having a sewage-farm a mile and a half distant from the town. The corrected mortality, as given by Dr. Prior, medical officer of health, is: Number of deaths, 1870, 348; 1871, 329; 1872, 326. Death-rate per 1,000 for the three years, 20.189.

Tunbridge Wells.

There are two irrigation-farms for disposing of the sewage of the 25,000 inhabitants of this town, as sufficient land could not be got in one place.

The northern farm, of 120 acres, is two miles and a half from the town. The land is quite hilly, and the sewage is conveyed in one case from one plot to another by an inverted

siphon. The distribution is performed by gravitation, and the carriers are ingeniously arranged so as to wind round the slopes and irrigate all parts in succession. The soil is tough and firm, and required underdraining. The sewage from the main conduit is collected in two large tanks for precipitating the bulk of the solid matters. This sludge, when removed, is the source of offensive odors which can be noticed at a considerable distance. When visited last year, there was pretty generally over the farm a slightly disagreeable odor arising from the carriers. It was found that they had not been thoroughly cleaned during the hurry of harvesting the crops.

Two useful acts may be learned here: 1st. That sewage-irrigation may be applied to uneven surfaces without undergoing the enormous expense of levelling the land. 2d. That sewage-farms require constant care to keep them from becoming nuisances.

The southern farm of 150 acres, three miles from the town, is an actual garden, covered with luxuriant crops,—grass, turnips, beets, carrots, hops, etc. Some of the roots were of extraordinary size. The fine herds of cattle feed on nothing but what is grown on the farm with sewage-irrigation, and they drink the effluent water. The soil is light, and has required underdraining in only a few spots. The land is hilly, and the sewage is distributed over it in open brick carriers by gravitation; no pumping is needed.

About a mile from the farm, tanks have been constructed for precipitating the solid parts of the sewage (chiefly sand), with the double hope of getting some revenue from its sale, and of keeping the carriers free from obstruction by deposits. The process does not serve either purpose. The farmers at first bought the mud at two shillings a ton; now they give sixpence a ton, when they are not busy, and have plenty of time to cart it. The tanks are a few rods from the road, and out of sight from it. Still, the complaints of bad odors, on the part of the many strangers who often pass, were so frequent, that now the sludge is stirred up every morning, and forced down the conduits to the farm with the liquid parts.

At the time of a visit last year, there was absolutely no unpleasant odor in any part of the farm. The conduits, how-

ever, if not running full, are the source of nuisance, unless they be frequently cleaned. This is done with stiff brushes.

In 1874, there was a clear profit of £40, after deducting all expenses, from the sale of the crops. In 1875, there was a deficit, owing to the frequent and heavy rains during the year. The farmer in charge, an educated agriculturist, complains that, under the necessity of keeping the streams pure, he must irrigate even when he knows it is doing harm to his crops. He thinks that the process is still in its infancy, that many improvements are to be made, and that sewage-farms will eventually become very profitable.

Leamington.

In 1870, the authorities of this town, having proved the precipitating processes to be costly and expensive failures,* gave up their tanks, and, in conjunction with the towns of Killington and Milverton, made a contract to deliver their sewage for thirty years upon Heathcote Farm, belonging to the Earl of Warwick.

The land is a rich loam, with a gravelly subsoil; it has been prepared for irrigation at a cost of £10 an acre, including levelling, subsoil-drains, carriers, etc. A million gallons a day, the sewage of 24,000 people, are pumped through a main conduit two miles and a quarter long to an elevation of 132 feet, the highest point on the farm,† whence it is conducted through earthenware pipes to the various parts of the farm, to be distributed by trenches dug in the earth. There are, in different parts of the farm, eight "hydrants" or wells, which are simply circular reservoirs, four feet wide, into which the sewage passes to be distributed in any required direction by means of four effluent main carriers, any one of which may be opened or closed at will.

Four men are kept steadily employed in attending to the details of the irrigation, turning sewage off and on, keeping trenches clear, etc., etc.

* After having expended £5,000 in litigation, the local board received an injunction from the Court of Chancery to cease putting either their sewage or the effluent from it into the rivers Avon and Leam.

† There is a reservoir capable of holding the supply of forty-eight hours; but it is to be used only in case of necessity, as the sewage is thought to lose materially in value by standing long enough for putrefaction to begin.

The surface-water, the great bugbear in sewage-irrigation, is diverted by storm-overflows into the River Leam.

The land is usually saturated with sewage before planting. Roots are irrigated for a few hours every eight days, and care is always taken, with all crops, not to let the sewage come in contact with the leaves. Eight crops of rye-grass (cut when about two feet high, and not ripe) are raised each year, and fed green to the stock. Mangolds (eight inches in diameter, and producing 82 tons to the acre), turnips (obtained fresh almost continuously through the season), luxuriant crops of wheat, hay, peas, beans, carrots, parsnips, cabbages, celery, rhubarb and strawberries, are raised here by sewage-irrigation, and reach the market earlier than those from other farms.

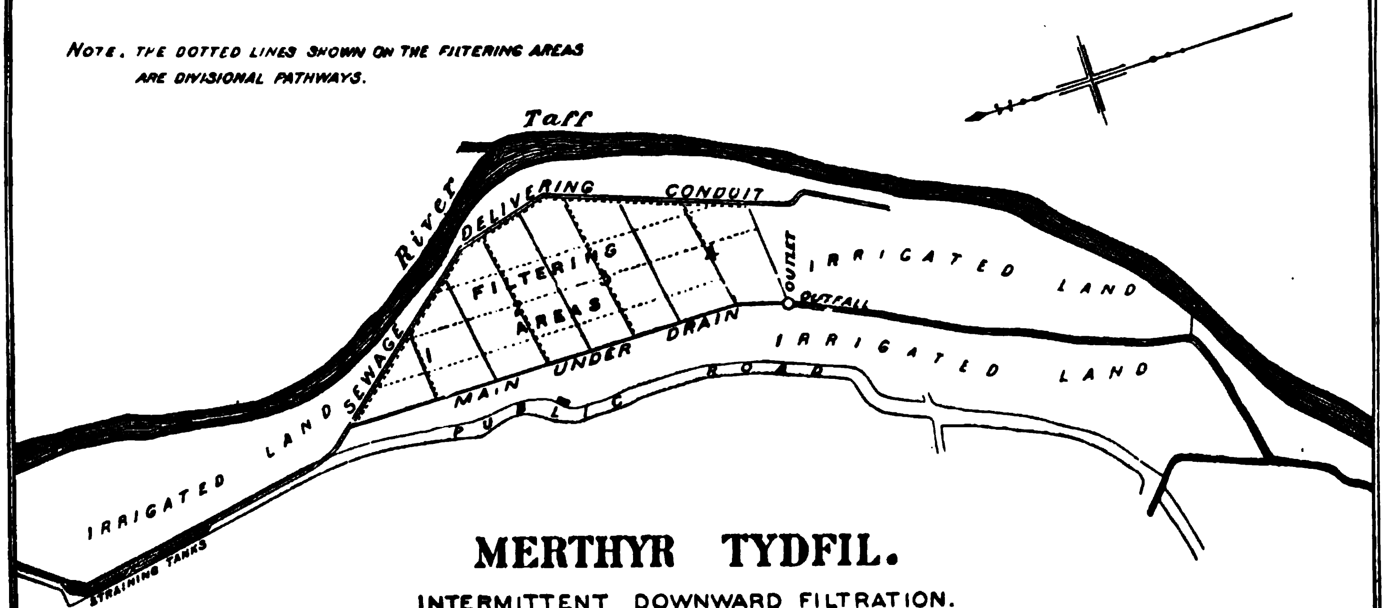
To sight and taste, the effluent seemed as good as the purest spring-water.

A herd of forty cattle is kept on the products of the farm, and they drink the effluent water mingled with that of a small brook. Even their pasture is irrigated. The beef, milk and butter find a ready sale, and command the highest market prices.

The result of four years' experience has shown that the land has increased very much in productiveness. There has been a large annual outlay for stock, etc., the benefit of which is just beginning to be felt. For the year 1875, in spite of a wet season, the income will, without much doubt, cover all expenses, including rent of land, interest on capital, etc., although the Earl of Warwick pays £450 a year for the sewage, delivered on the farm. This success is due to the excellent management of Mr. Tough, the earl's manager, as well as is the fact that not a single complaint has ever been made of any offence.

The rate-payers expended, in 1874, £1,046 to deliver the sewage at the farm. In return for this they received £450 from the Earl of Warwick, leaving £596 as the cost to them for the year. The cost of pumping, including fuel, is over £600 a year. Therefore, if the sewage were delivered by gravitation, without pumping, there would be quite a fair profit on the whole operation.

The accompanying map, for which I am indebted to Mr.



MERTHYR TYDFIL.

INTERMITTENT DOWNWARD FILTRATION.

Scale 12 Chains to One Inch.

Tough, shows the important facts with regard to the farm. The sewage-carriers are under ground, follow the boundaries of the various fields, and are not indicated on the map. The subsoil-drains, as shown, discharge into the brook. The limit of the irrigated area is marked by a heavy black line.

Merthyr Tydfil, Wales.

In the early part of 1870, application was made to parliament for power to take land for irrigation, and an Act was passed some months later giving the town power to take a lot of 393 acres. Those persons who had obtained the injunction forbidding the town to pollute the river Taff, which had led to the application to parliament, were not satisfied that the nuisance would be removed speedily enough. They therefore applied for a second injunction, when the matter was placed by the court in the hands of Mr. J. Bailey Denton, who determined to carry out the system of intermittent downward filtration suggested by Frankland.*

The sewage of 40,000 people passes from the town, three miles distant, by the action of gravitation. On the way to the farm it flows through a straining-tank, filled with refuse slag from the iron-works, by which the coarser parts are intercepted.† It is finally distributed, through covered earthenware pipes, upon a field of twenty acres, divided into four plots of equal size, each of which is used six hours at a time, with eighteen hours of rest for aeration. The four plots are marked 1, 2, 3, 4, on the map.‡ The sewage flows uniformly

* This method has been in use for two seasons at Kendal, where 400,000 gallons, the sewage of 13,500 people, are filtered on five and a half acres of land. The effluent is a colorless and fair potable water. In ordinary weather, when the river is at its medium level, the outflow from the underdrains averages one-third of the quantity of sewage delivered on the land, the remaining two-thirds being lost in the gravel. When the river is low, the whole sewage disappears in the gravel subsoil. Crops were sold, the first year, for £150, or £80 less than the expenditure, making a tax on the rate-payers one-half as great as is required to carry on the Croydon farm.

A third town—Rotherham—has recently applied to Mr. Denton to introduce his system there.

† It was found that without this precaution the surface of the filtering-area became somewhat clogged.

‡ This map is copied from one given by Dr. T. J. Dyke, in a paper read at the annual meeting of the South Wales and Monmouthshire branch of the British Medical Association, in 1872.

over each plot, with a fall of one in one hundred and fifty from the conduit to the main underdrain, where it is arrested by an embankment. The main underdrain is six feet deep, and serves to carry off the effluent to the river. The lateral deep drains are of the same depth, and placed only twelve feet apart.

The soil is admirably adapted to this system, being a light loam, with a gravelly subsoil in some places sixty feet deep. The effluent is quite pure,* as is shown in the accompanying table, furnished by Dr. Dyke, and far above the standard demanded by the Rivers Pollution Commission. Their standard, indeed, is not yet enforced by law, is not attained by any of the precipitating processes, and is thought by many persons to be too high. The Thames Conservancy Board are somewhat more easily satisfied, but have been criticised adversely for that very reason.

* It should be said that it is mingled with quite a large subterranean stream, and is therefore much diluted before its final discharge into the water-courses.

Results of Analysis Expressed in Parts per 100,000.

[Analyses by Dr. Ed. Frankland.]

DESCRIPTION.	Total solid impurity.	Organic Carbon.	Organic Nitrogen.	Ammonia.	Nitrogen as Nitrates and Nitrites.	Total combined Nitrogen.	Chlorine.	Suspended Matters.		
								Mineral.	Organic.	Total.
Permitted by proposed standards of purity,	Unlimited.	2.000	.300	Unlimited.	Unlimited.	Unlimited.	Unlimited.	3.00	1.00	4.00
Merthyr sewage, after treatment with lime, but before intermittent filtration, June 19, 1871,	54.00	2.788	.783	4.854	0	4.780	7.00	6.68	10.12	16.80
Merthyr sewage, after intermittent filtration, June 19, 1871,	34.60	.249	.056	.075	.231	.349	3.00	trace.	trace.	traces.
Merthyr sewage, after treatment with lime, but before intermittent filtration, October 20, 1871,	49.20	1.282	.952	1.280	.052	2.058	5.25	7.88	6.56	14.44
Merthyr sewage, after intermittent filtration, October 20, 1871,	33.48	.323	.107	.058	.300	.455	2.60	trace.	trace.	traces.
Mean of sewage, after addition of lime,	51.60	2.035	.867	3.067	.052	3.419	6.12	7.28	8.34	15.62
" " after intermittent filtrat'n,	34.04	0.286	.081	0.066	.265	0.402	2.80	trace.	trace.	traces.

Total organic matter, after liming, ... 5.454

" " " after filtration, ... 0.688

Contrary to the expectation of the Rivers Pollution Commission, it was found that good crops could be raised on land which received such an enormous quantity of sewage. It was also feared that the soil would become clogged in the course of time. The experience of five years at Merthyr has shown that this is not a likely result, at least with a gravelly subsoil.

In 1872, fifty-five acres, and in 1875, one hundred and fifty acres were added to the farm for ordinary irrigation; not because intermittent downward filtration was inadequate to purifying the sewage, but because the local board desired to have the benefit of the additional land for raising crops to repay their annual outlay. The filtering-area is now used half the time. Large crops are raised in both fields.

The summer is shorter in Wales than in England. The first crop of rye-grass is cut in April, the last in November; there are four in all.* The ground freezes to a depth of two feet; but, as the sewage is warm, this does not interfere seriously with irrigation.

The cost of carrying on the farm is about £1,050 a year, against £1,000 received from sale of crops. Here, as elsewhere, the testimony is freely given, that under private management the farm would undoubtedly be profitable. Corporations do not make good farmers.

In Dr. Dyke's report for 1874, he has given interesting testimony as to the milk of cows fed on sewage-grown grass. The district is occupied largely by miners who have large families. Dr. Dyke testifies to the good health of the children, as follows: "There are many hundreds of children brought up on this milk of cows largely fed on sewage-grass, and the death-rate from diarrhœal diseases is very low."

Gennevilliers, France.

Two hundred wagons are employed in Paris in emptying the cesspools, and the cost is 1,600,000 francs a year. As the scavengers are obliged to enter narrow courts, and even cellars, in their work, the stench, in spite of disinfectants, is often intolerable. Seven hundred and fifty thousand cubic

* At Croydon, eight crops are cut; the first in January, the last in December.

meters of the cesspool-matter is piled up at Bondy, just outside the city, and the authorities do not know what to do with it. In the meantime, the Seine has become so seriously polluted with the sewage of the city, as to give occasion to frequent and loud complaints, while 200,000 francs a year are expended in removing from it sewage-deposits.

Under such circumstances, the use of the water-closet is becoming more and more general, and the opinion is pretty well established that the filth of the city sewers must be purified by irrigation.

In England, a great obstacle to successful irrigation has been the fact that the land is held by wealthy land-owners, who demand exorbitant prices for it. As great a difficulty is encountered near Paris, from the land being parcelled out in small lots, owned by an ignorant peasantry who are very capricious, sometimes wanting the sewage and sometimes not.

Experiments begun in 1867 on a small farm of twelve acres, carried on by the sewer department, showed very favorable results, and farmers applied to have the sewage applied to their land. The place selected was a peninsula of four thousand acres formed by a bend of the Seine, quite flat, lying six or seven meters above the bed of the river, and having a poor, alluvial soil, largely sand and gravel. It is, of course, admirably suited to the purpose.

Up to 1874 the area irrigated was considerably extended each year, at the request of the farmers holding the land. During 1875, scarcely any additions were made, although the city is glad to deliver the sewage free of charge upon any lots in the vicinity. The land is so near the city (a mile and a half beyond the walls), that the owners are beginning to think that its use in this way will prevent their getting larger profits from its sale for building purposes, docks, etc.

The main sewers of Paris have two outlets. At Clichy, 260,000 cubic meters of sewage are discharged daily, of which 40,000 are forced by pumps across the river through iron conduits passing along the framework under the bridge. At St. Denis, 50,000 cubic meters are discharged each day; this can be distributed by gravitation. The main carriers are of brick; the laterals are simply small trenches in the earth. For summer-irrigation, beds are made a single meter in width, over

which the sewage does not flow, but through which it must sink from the trenches, finally reaching the roots. Winter-irrigation consists in flooding the land several inches deep. The level of the ground-water is from four to six meters below the surface, and the land is very porous, covered with a layer of fine sand, so that a single acre is sufficient to purify the sewage of seven hundred persons.* The farmers use the sewage, or let it run into the Seine, as they feel inclined.

The crops raised are almost exclusively vegetables for the Paris market. They are bought readily; the Grand Hotel is supplied with them. In fact, the products of the sewage-gardens, being large and fine looking, command the highest prices, a single acre often yielding a return of fifteen hundred or two thousand francs a year.

When the farm was visited, there was what is called in England a stink over the whole place, which was attributed to three causes: 1. The sewers of Paris not being self-cleansing, the sewage has advanced somewhat in putrefaction before reaching the fields. 2. The trenches for distributing the sewage were foul, as the liquids stand in them for so long a time. 3. The heat is more intense in France than in England.

No ill effect, however, has been noticed on the health of those residing near, though a village has sprung up in the very midst of the sewage-plots.

The city has expended several hundred thousand francs in pumps, etc., to carry out this enterprise, for which they have no return. The authorities are now carrying out a project which will make them independent of the petty land proprietors. This consists in carrying the sewage still farther down the river, and using it on some land belonging to the State.

It has been proposed to carry an intercepting sewer down nearly to tide-water, and to utilize the sewage on all proper places on the way, so that the farmers can use it when they consider it for their profit to do so, and at other times let it go. The land-owners at Gennevilliers have found out what has been learned over and over again in England, that, if they purify all the sewage by irrigation before letting it run into the rivers, they cannot expect the profits to be large.

* Seven hundred and fifty acres have been thought by the Berlin Commission sufficient to purify the sewage of that city; or one acre for about a thousand persons.

The only experiment at Paris which is satisfactory from a sanitary point of view, as affording a solution of the question of purifying the river, is that of Mr. Hope; but he has found it impossible to get over 108 acres of land. His farm is managed precisely like his other, so well known, at Romford.

Dantzic, Germany.

When the English contractors Aird undertook to build the system of sewers so scientifically planned by Wiebe for this city of 80,000 inhabitants, they agreed to keep them in order and to purify the sewage by irrigation for thirty years, at an annual expense to themselves of about $6,000 or $7,000 for keeping the pumps and conduits in order alone. They were to have the rent of 1,000 acres free, and all the income from the crops accrues to them. The sewage is carried nearly three miles, and is at present applied to 250 acres of what was at the beginning of the experiment an almost barren sand-beach close to the edge of the Baltic Sea.

During the first year, so much time and expense were laid out in levelling the sand-hills, and the sand itself blew about so much, that the results were not very encouraging. The preparation for the sewage of a single acre often cost sixty dollars.

In 1872, however, the second year of the experiment, fifteen acres were got under cultivation; and now 250 acres are covered with luxuriant crops, while some of the land has become very fertile.

On the 1st of January, 1875, according to the report of Mayor v. Winter, there were cultivated as follows:—

Rye-grass,	82 acres.
Turnips,	45 "
Rape,	17 "
Beet-root (the previous year with oats),	30 "
Buckwheat,	25 "
Barley,	6 "
Tobacco and maize,	6 "
Swedes (the year previous with beet-root and flax),	7½ "
Caraway seeds,	¾ "
Aromatic herbs (such as thyme, lavender, etc.),	25 "
Vegetables,	5 "
Flower-beds and strawberries,	¾ "
	250 acres.

The sewage is conveyed to the farm by pumping it through a sewer four miles long, to a reservoir, whence it is carried by a single large conduit, passing through the farm, to the sea. This is made of wood, a poor conductor of heat, to protect the sewage as much as possible in winter. The distributing carriers are simple trenches, at a considerably lower level, so that the sewage may run freely during cold weather.

The trial at Dantzic is of especial interest to us, inasmuch as it was undertaken for economical reasons, to save the sewage and to reclaim some almost worthless land. Moreover, the climate is quite like that of Massachusetts, with the same intense heat in the summer and almost as great severity of cold in winter.* The ground is usually frozen to a depth of three or four feet, for about three months; the snow is often several feet deep.

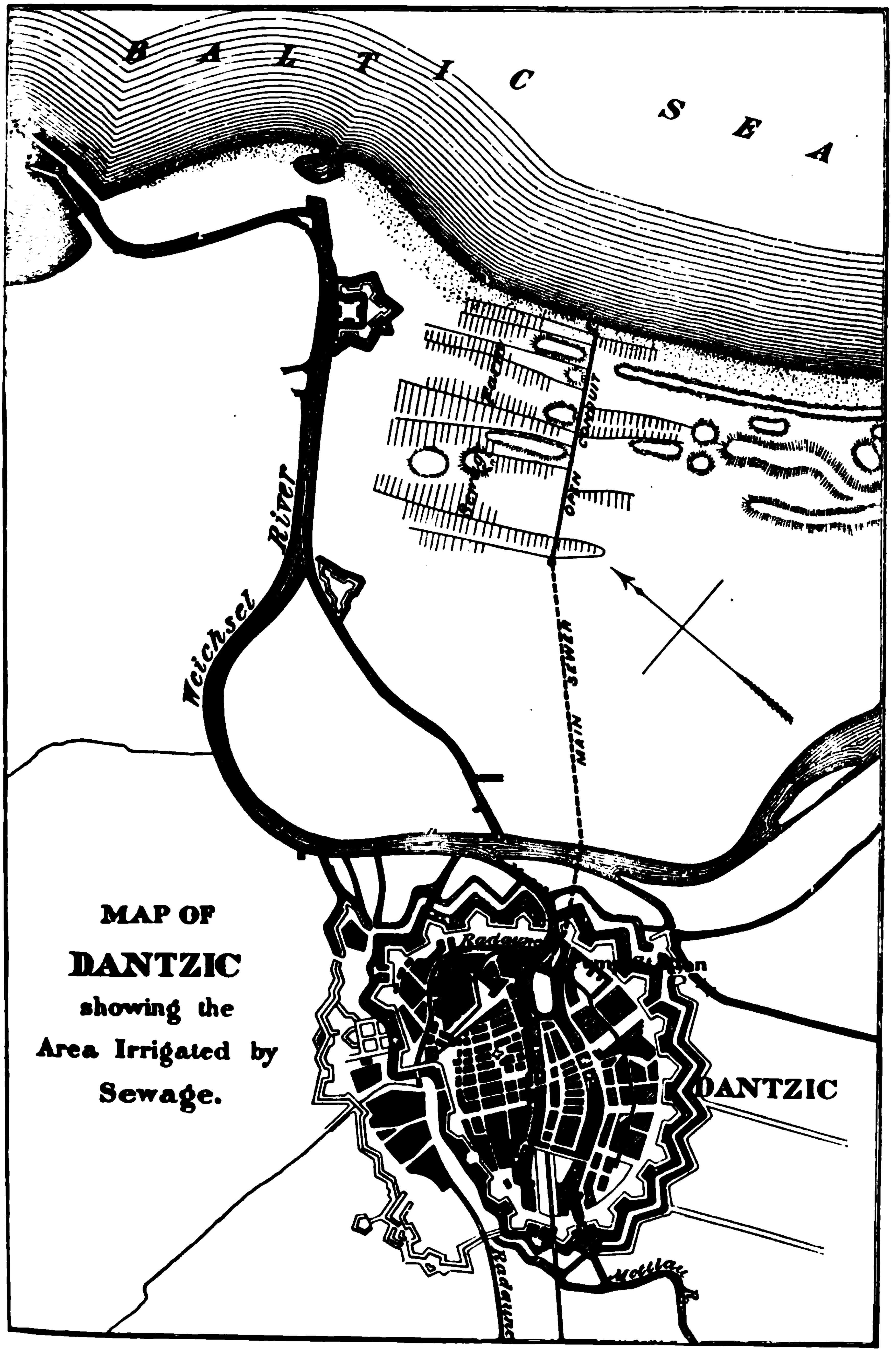
The sewage in the main conduit is kept at a depth of a foot and a half, and is constantly flowing. It maintains a temperature, in winter, of 50° to 60° Fahr.: much higher than the summer temperature, on account of the free use of hot water at that time in the city. It flows out under the snow, through the many furrows prepared for it, leaving a thick crust to be ploughed into the land in the spring. About thirty feet from the conduits the sewage often freezes; and during the months of extreme cold, though the sand is so porous that the sewage sinks into it readily at all times,† filtration alone can be depended upon. Nevertheless, if the plots of land are large and frequently changed, the purification of the sewage is, even in winter, more complete than can be accomplished by any of the precipitating processes.‡

From a sanitary point of view, sewage-irrigation has proved a marked success in Dantzic. A map, showing the general plan of the city and of the farm, is here given.

* In the winter of 1874-75, the mercury stood at -17° Fahr. It reaches -6° or -8° every winter.

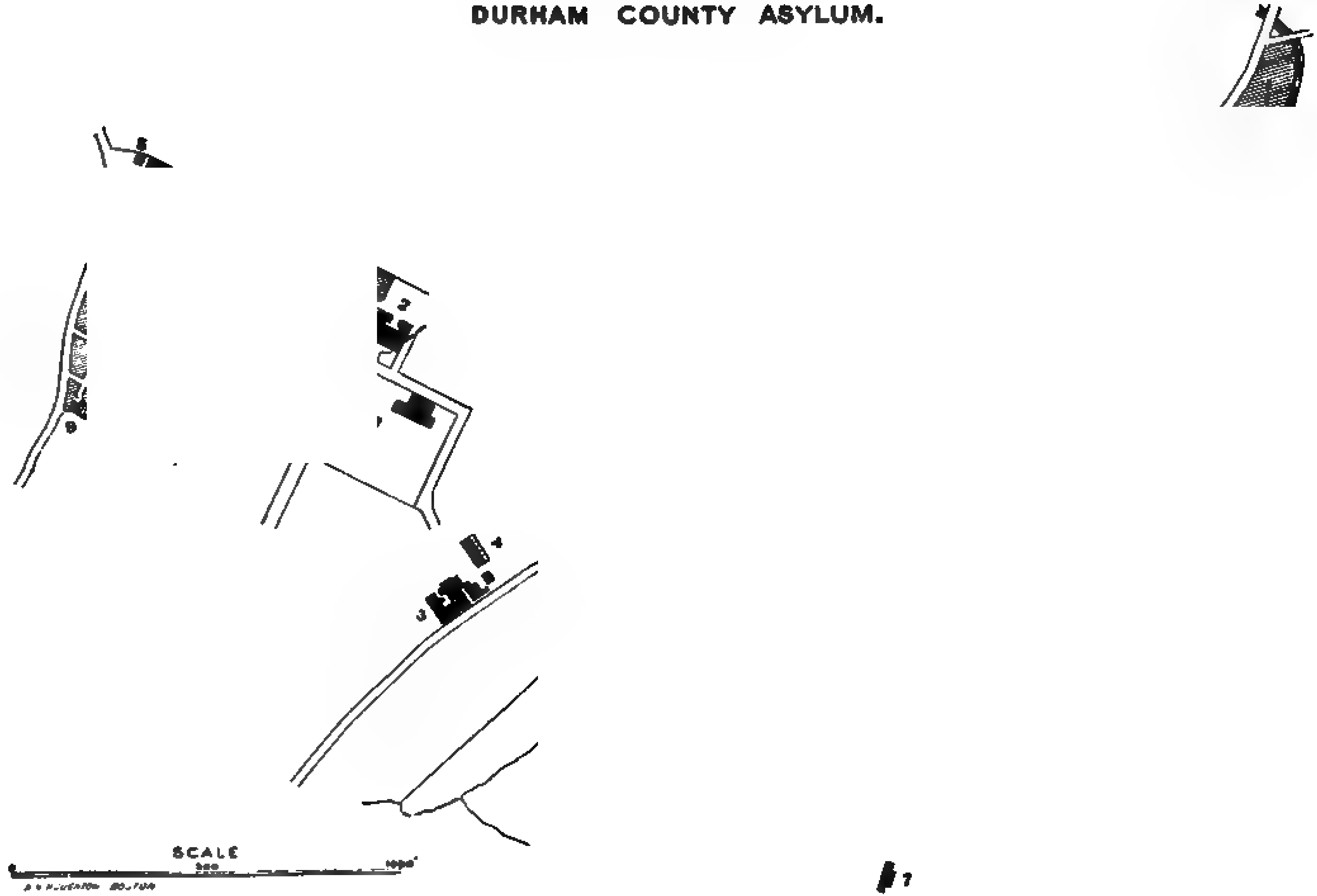
† Three times only, in January and February, 1875, and then for only a few days at a time, has irrigation at Dantzic been stopped by the cold. Roots of grass are destroyed by ordinary winter-irrigation. If, however, they are kept constantly covered with sewage, no harm is done.

‡ That there would be danger in using water from wells near by, is evident. Such water cannot be safely drunk at any time.



MAP OF DANTZIC showing the Area Irrigated by Sewage.

DURHAM COUNTY ASYLUM.



Durham County Insane Asylum, England.

In the accompanying sketch, taken from one of the reports of the Rivers Pollution Commission, the irrigated land, thirty-one acres and a half, is shaded, the vegetable-garden being quite close to the walls of the asylum. The main carriers for the sewage are represented by dotted lines. The asylum, with five hundred occupants, is represented by the figure 1; 2 is a workshop; 3, 4, 6, 7, 8 and 9 are farm-houses, porter's and gardener's houses, and cottages.

This method of disposing of the sewage of public institutions is quite common in England. It has been very successful, both from a sanitary and an economical point of view. In some asylums, all the vegetables used during the year are raised by sewage-irrigation. In such places, the labor costs almost nothing; and every additional interest or occupation benefits the patients in a degree which it would be difficult to measure in dollars and cents.

Dr. Boyd, medical superintendent, and Mr. Whitehead, C. E., testified that sewage-irrigation had been in use at the Somerset County Asylum for nineteen years; that the land had very much improved in value; that the sewage was completely deodorized soon after its application to the land; that there were no bad smells even in warm weather, and that no sickness or unpleasant results had been in any way due to irrigation with the sewage.

Augusta, Maine.

The sewage of the State Insane Asylum, in this city, became so offensive, that Mr. C. B. Lakin, the treasurer, carried out a system of irrigation which has been very efficient, and which is almost the only one which has stood the test of experience in this country.

The sewage passes by gravitation into large tanks, where it is mixed with a large amount of absorbents (straw, leaves, muck, etc.). The solid parts are from time to time carted on to the land, and the liquid passes off, often quite clear and sparkling, to be used on the land in irrigation. A portion flows over a few acres, from which three crops of fine hay were cut last summer. Another portion is used in hose-

irrigation of the vegetable-garden, care being taken not to sprinkle the leaves. A third part is carried to different parts of the farm and distributed from a cart, which is made to discharge the sewage upon the land by the removal of several plugs. It is filled from the top, and acts on precisely the same principle as an ordinary street-watering cart, although different in construction. Even if clear, transparent, and odorless, this fluid soon becomes turbid, foul-smelling, and finally almost black.

Seven thousand gallons of sewage are disposed of in this way each day. The results obtained have been as follows:—

1. What was formerly a nuisance has become inoffensive.

2. The hay-crop on the land irrigated by gravitation has increased sixfold. The other crops have increased somewhat.

3. The expense is fully met by the greater value of the crops raised. It should be said, however, that much of the labor is performed by patients, and costs nothing.

4. Most important of all, the fact is established that sewage, at least on a small scale, can be purified by the soil, in our climate, even in the winter. When the mercury stood at nearly 0° Fahr., and the ground was frozen hard, the sewage was found to disappear very soon after it was put upon the land. In the spring, the early rains wash any refuse that there may happen to be deep into the soil, and no offensive odors are noticed. The surface of the ground is then sometimes found covered with a brownish scum.

The "Waste of Sewage."

Captain Vetch, R. E., estimates the value of the *excreta* of one individual to be $1.25 a year. Dr. Thudicum places the average for all ages at $2.12; and some of the German observers consider it worth $2.60. Upon these and other estimates, Liebig, Lawes, Gilbert, Hoffman and Way, and others, give to the ordinary sewage of English cities a value variously estimated at from one cent to four cents a ton. Considering the large amount of water used in this country, and our greater rainfall, it is probably fair to place the theoretical value of the sewage of our cities not higher than one cent a ton. It cannot be said to have any commercial value,

as the cost of utilizing it must exceed any return that could be obtained under most circumstances. In regard to public institutions, jails, etc., where labor could be got at small cost, and where it is a decided advantage to be able to give the inmates any employment, the experience of the asylum at Augusta warrants us in saying that sewage can be utilized, even in our climate, without loss.

From a large number of analyses published in the fourth report of the State Board of Health of Massachusetts, the late Secretary of the Board and Prof. Nichols estimate the sewage of Boston to possess one-half the fertilizing properties of the average sewage of English cities and towns, and to be worth about one cent a ton. This estimate was based chiefly upon the proportion of ammonia present. If we use the "total solid matter in solution" as a basis for our comparison, Boston sewage will be seen to have a somewhat higher comparative value, even after making due allowance for a large excess of salt in it. In a word, our sewage is more dilute, as we use water very freely for all purposes.

Considering the very dry character of the soil near Worcester, and the parching heat of our summers, however, this dilution may prove a benefit, rather than an evil, at least for that locality. Arrangements can easily be made to exclude the greater part of any excessive rainfall* from the irrigated fields.

The comparative values of our sewage and that of other places, may be approximately estimated from the following table:—

* Our water-supply and our rainfall are both about twice as great as in the majority of the English and German cities and towns, which have adopted sewage-irrigation. They are about the same as in West Derby.

Table showing the Composition of Sewage.

[Parts per 100,000.]

COMPOSITION.	Boston.*	Worcester.*	Fifty English cities and towns—average.†	Dantsic.‡	Berlin.§
Total solid matters in solution, .	58.96	25.35	72.2	68.3	78.9
Total suspended matters, . .	37.34	21.16	44.69	58.2	51.
Organic nitrogen, . . .	–	–	2.205	1.16	1.23
Total combined nitrogen, . .	–	–	7.728	6.48	–
Ammonia, ...	2.72	1.876	6.703	6.46	–
Nitrogen as nitrates and nitrites,	.036	.134	.003	0.00	–
Chlorine, ...	18.94	4.17	10.66	6.97	–
Phosphoric acid, ...	1.69	.66	–	.26	1.58

NOTE.—The sewage of Paris contains $\frac{37}{96}$ as much ammonia, and [illegible] as much phosphoric acid, as that of London, according to Freycinet.

* Analyses by Prof. Wm. Ripley Nichols.
† Analyses by the Rivers Pollution Commission.
‡ Analyses by Dr. Otto Helm.
§ Analyses by the Royal Commission.

Precipitation by chemical processes was referred to by Hoffman and Witt in the report of the Metropolitan Main Drainage Commission, in the following language, which fairly represents the opinions reached in France, Germany and England.

"The problem of profitably recovering the valuable constituents of sewage remains, up to the present moment, altogether unsolved; and very faint indeed are the hopes that the progress of chemical discovery will supply the means of so doing. The valuable constituents of sewage are like the gold in the sand of the Rhine: its aggregate value must be immense, but no company has yet succeeded in raising the treasure."

In the present state of chemical science, then, irrigation must be said to be the only method by which we can hope to get satisfactory results in purifying our sewage.*

In our seaboard cities, this is not at present advisable; nor is it necessary in cities like Springfield, which are situated on large rivers; with others of our cities and towns, the case is

* During our winters, the most successful of the precipitating processes could not be otherwise than enormously expensive, beside being otherwise unsatisfactory in its results.

different. The present condition of Woburn and Worcester, for example, demands some remedy; other cities and towns are likely to be soon in similar positions. Filth in our rivers is certainly "matter in the wrong place"; but in and near our houses, contaminating the soil, and water, and air, it is in a much worse place. Neither evil is necessary.

If irrigation with sewage, on a large scale, has been uniformly unprofitable in other countries,* it is likely to be still more so here, considering the length and severity of our winters and the greater dilution of our sewage. In spite of all this, it has been seen that mistakes have been made, in England and elsewhere, that we may avoid; and while there are many facts which lead us to believe that sewage-irrigation on a large scale may be carried on in our climate without much pecuniary loss, we must acknowledge that this is a matter which can be decided only by actual trial, and that the experience of other countries will not decide all the difficulties which may arise here.

It is but fair to say that many competent investigators consider the question of sewage-disposal still unsolved, and fully expect that chemistry is yet to come to our relief. If, however, as a distinguished authority has said, fourteen years of research are required for each new discovery in science, we should not be justified in suffering a great evil to go without remedy, in anticipation of an event which may not occur in this generation or the next.

The Conditions of Sewage-Farming.

The conditions of successfully managing sewage-farms are, with some modifications, essentially the same in all countries. Differences in climate, amount of rainfall, composition of the sewage, character of the soil, etc., will naturally occasion varieties of practical difficulties, which will be met in different ways in different countries and in different parts of the same country. For general rules in this matter, we cannot do better than refer to that nation which has had the largest

* In 1873, the English government published a return of forty-four cities and towns, which were purifying their sewage by irrigation, through loans from the general treasury. Not one was found to be paying all expenses.

experience, and we therefore quote the First Rivers Pollution Commission,* of England, as follows:—

"A sewage-farm requires special and peculiar management; the operations should be specially adapted to this mode of culture, and then it will be found that any land may be improved. The operations do not turn clay-lands into swamps, though sixty inches in depth of sewage are added to the rainfall.

"The dressings with sewage must be even, and at regulated intervals. In all cases, sewage should be used fresh; that is, before putrescence has set in, so as to prevent any effluvium arising from the irrigated land.† Where this is the case, there cannot be any just grounds for complaint.

"Where clay-lands are irrigated, and the contour of the land will admit of the operation, a second and even a third use of the water may be made with advantage.

"Sewage-irrigation works cannot be too simple in their character; the application should be by surface-carriers, not by underground piping, and hose, and jet.

"Land which has been worked in ridge and furrow, will require levelling; that is, the soil should be stripped, and the ground be broken up, so as to bring the surface even.

"Main carriers should be laid in nearly level lines, so as to command the area below, and secondary carriers, from half a chain to a chain apart, should contour the entire surface. The main carriers may be covered in, having valves or sluice-boards, of an inexpensive and simple kind, to retain and let out sewage as required. The main carriers will be of brick or of earthenware pipes, in size proportioned to the volume of sewage to be distributed. Conduits below eighteen inches in diameter may be made most cheaply of earthenware pipes; brick-work may be cheaper for conduits of larger cross-sections.

"Small carriers may be formed of small agricultural tiles, but jointed and laid only three parts in the soil, so that one tile. or more than one tile, can be removed temporarily at any point to allow of surface-overflowing at such points when the tiles are removed for this purpose. All ordinary conduits may be open trenches, readily formed by hand-labor or by the plough. These subsidiary contour-gutters must not necessarily be looked upon as permanent.

"After one sowing of Italian-grass has run its course (this

* Second Report, pp. xv. and xvi.

† Putrefaction also lessens the value of sewage as manure.

should not exceed two years), these minor conduits may be ploughed up with the rest of the land. Some farmers will probably clean the land by taking a root-crop off it, and then lay it down again for a second course of Italian rye-grass, and so on.

"Proper irrigation and cultivation neither fouls the land nor exhausts it.

"Where sewage-irrigation is the cause of a nuisance, it will be found either to proceed from use of old and putrid sewage in large and foul, open, ditch-like carriers, or from open tanks and large carriers being allowed to become foul.

"A sewage farm not only requires a peculiar mode of cultivation, but also special management in dealing with the produce. Tolerably good land, under sewage, will produce from five to seven crops of Italian grass per annum, weighing, in the aggregate, when green, from fifty to sixty tons per acre. A first cutting at Worthing, in May, 1865, was from twenty to twenty-five tons per acre.

"The grass is used to best advantage on the day it is cut, and is most profitably applied to stall-feeding dairy-cows. With such rapid growth and weight of grass, a special market for the produce of the land must be provided to prevent waste, failure and disappointment; but, as milk and butter are a necessity, and as good milk and butter will command a preference in the market, there need not be any difficulty with a sewage-farm because of its great productiveness. This has been, however, a complaint made against sewage-irrigation in some places; a market did not offer means for immediate sale, the grass spoiled in keeping, and therefore the experiment was pronounced a failure.

"In course of time, sewage-farming will become a special business, and when it is found that there is more profit in a sewage-farm than in an ordinary farm, the system of sewage-irrigation will have been solved.

"Where there is sewage there must be population. Milk, butter and beef will, therefore, be in proportionate demand; so that, when the true use of sewage is understood, that which is the cause of nuisance, by being wasted, will be turned to profit on the land."

In preparing these notes, it has been the endeavor, so far as possible, to get information at first hand. Most of the places described have been personally visited, and generous assistance has been most readily given by physicians, engineers and others, for which the writer desires to express his acknowledgment and cordial thanks.

IV.—SUMMARY AND RECOMMENDATIONS.

From all the cities, and from one hundred and sixty-nine of the towns in the State, we have received replies to our circulars. As a rule, towns not reporting are very small, and dispose of their refuse in the rude and unsatisfactory method common in country places.

Eighty-seven cities and towns report more or less offence from incompletely removed sewage; in twenty-four of them disease is supposed to result therefrom; and in eight it is the *suspected* cause of disease.

Forty-eight cities and towns, with an aggregate population of 969,921, have introduced partial or complete water-supplies, while only twenty-four, or one-half of them, have provided even partially for the proper removal of such large quantities of water by sewers. Of these twenty-four, six cities have sewer-outlets into salt-water; six cities and towns into tidal streams, and twelve into fresh-water.

Forty streams and eleven ponds receive sewage, either by direct or indirect drainage into them. Forty-six cities and towns report that their present methods of dealing with sewage are objectionable; and the evils of these conditions are rapidly growing. Nineteen report that their sewage seriously pollutes the atmosphere. One hundred and twenty-eight towns have wet or damp cellars; that is, they are suffering from the want of proper drainage of the soil.

In all of these cases, the law fails to provide a prompt and effectual remedy. In two instances in this country,—namely, in Worcester and in Baltimore,—damages have been paid for the nuisance or injury caused by the pollution of streams; but the process is so slow and cumbersome, and often attended with so much personal feeling, that individuals and towns seldom seek redress in that way.

In the Miller's River Basin, the nuisance became so intolerable to so large a community, as to require special legislative action for its removal. The abutters on the Broad Canal in Cambridge have obtained an injunction from the supreme court, forbidding the city of Cambridge from discharging their sewage into that stream, to the great injury to health and property in that vicinity; and an intercepting sewer is building out to deep water.*

The most wide-spread evil in our State brought out by these investigations, is dampness of soil arising from incomplete *drainage*; that is, removal of water from the soil.†

The remedy for this condition is, in scattered communities, chiefly in the hands of individuals, and consists in thoroughly draining all soil near dwelling-houses by porous pipe-drains. In cities and towns, the same end is often attained in laying ordinary sewers, whose chief object is the removal of refuse, but which, as almost universally built, serve also for removing surface-water and a certain proportion of the water in the subsoil.

A large part of the filth in our State contaminates the air and the soil, and often the water which is used for domestic purposes, by being thrown upon the surface of the ground, or collected in loose-walled vaults and cesspools. The evil sometimes appears in a different form, when filth finds its way into small streams. The remedy for this condition of things must be governed by local circumstances affecting each case. Neither all towns nor all individuals can always afford to have what is absolutely the best means of removing refuse, and which consists in well-ordered water-supplies, water-closets, sewers, and proper methods of disposing of sewage. This is too costly to admit of universal application.

* It may at any time become an important question to an individual or a community, what protection the law affords against the fouling of one's water-supply by others. In the present state of the law, it can only be said that each case must be decided on its own merits, under the common law. The English reports give many instances of injunctions granted to restrain the pollution of streams from the year 1388 A. D. down, but no instance of an award of damages for injury from such pollution. In the United States, however, there have been instances of award of damages in such cases.

† Compare Mr. Kirkwood's Report, p. 152; Dr. Winsor's Report, pp. 227, 228; also a Report on "Drainage for Health," by H. F. French, in the Fourth Annual Report of the State Board of Health.

The substitutes for water-closets are fully discussed by Dr. Winsor. The objects to be attained by them may be briefly said to be,—

1. Frequent disinfection with dry earth, and prompt and complete removal of all excrement.

2. Disposition of slop-water in such a way that it cannot putrefy and contaminate the air in the neighborhood of dwelling-houses. This is well attained by a system of irrigation* used by Mr. Rogers Field, of London, and in successful operation in Newport† for some years past, in the hands of Col. G. E. Waring, C. E., with the simple drawback that care is required in cleaning the pipes each year. It might be successful, also, in the climate of Massachusetts.

Where this cannot be done, the safest way is to dispose of slop-water on the surface of the ground, not near dwellings, where the organic matters in suspension and in solution will be taken up by vegetation. This method would be attended with difficulties during the winter months; but they are not insurmountable. All tanks, reservoirs, cesspools, etc., for storing liquid or solid refuse, must be always looked upon as likely to cause serious trouble under the immense majority of circumstances.

Where water-supplies have been introduced, sewers should be built coincidently, or follow immediately afterwards. The only alternative at all satisfactory consists in having tight cesspools, emptied frequently by an odorless process.‡ In Paris and in some other cities, such cesspools have existed for many years without other serious ill result, except at rare intervals, than in the great nuisance and in some cases disease caused by the process of emptying them, many of them being in cellars and narrow yards or courts. In Cincinnati and Baltimore, loose-walled cesspools are common. In both cities a serious amount of pollution of the soil is said to have already taken place. That this pollution may exist to a great degree in a city where the death-rate is low, as in London, is true; but there are so many sources by which putrefied organic matters from them may get into the water

* Second report of the Medical Officer of the Privy Council, new series, London, 1874, p. 233.

† See page 334. ‡ See page 188.

we drink or the air we breathe, that cesspools should be tolerated only in case nothing better can be got. Legislation on this subject we should not consider at present expedient.

Many small streams in the State are used for the overflows of cesspools, or for the direct emptying of house-drains. Wakefield presents a considerable degree of illness and some mortality, a part of which it seems fair to attribute to this cause. In Chicopee, the amount of illness has sensibly decreased since the conversion of such a stream into a covered sewer. We must wait for the experience of several years, however, before we can speak conclusively on this point.

Even if there were no danger to health, as there must be in some cases, from the use of small streams as open sewers, they should not be used as such on account of the offensive odors arising from them. If they are covered, there are other difficulties; for they pollute the soil if built up of loose walls, and if tight they lose to some extent their power of draining the soil. Unless they are of enormous size, too, they are liable to be flooded in case of a storm, while they are during drought nearly empty, and receptacles of sewer-gases. When it becomes necessary to convert such streams into sewers, the walls should be made tight, and porous drains should be used in conjunction with them for rapidly removing the water from the soil.

Water-supplies necessitate sewers; and sewerage-systems in most countries involve pollution of streams. Offensive as this pollution may be, it is less dangerous to health than retaining filth about our dwellings in vaults and cesspools.

In Salem, Lynn, Haverhill, Worcester, and Boston, with its adjacent cities, the nuisance from putrefying sewage incompletely removed has become a serious evil. The remedies must be determined in each case by careful especial study by experts. We can only say that the principle should be established that each community should dispose of its own filth without allowing it to be a source of offence to others. In the seaboard cities, some modification of a system of intercepting sewers will probably prove the most ready solution of the difficulty. In inland cities and towns, irrigation would be likely to be successful, and not involve a large annual cost;

after some experience, it is very likely that even a profit may be realized from it.

The facts that the pollution of rivers is a growing evil, and that irrigation with sewage is the only remedy which promises well, should make it of the greatest importance that the experiment should be tried, on a small scale at first, so that some definite results may be got for future legislation.

With our hot and dry summers, it is possible that irrigation will be nearly if not quite as successful as in England, in spite of our greater rainfall, and the greater dilution of our sewage.*

Winter-irrigation will undoubtedly present difficulties which can be fully met only as experience teaches us what is best. The experiments made in Augusta, Maine, show that a small amount of sewage, at least, may be successfully disposed of upon the soil during the winter months.†

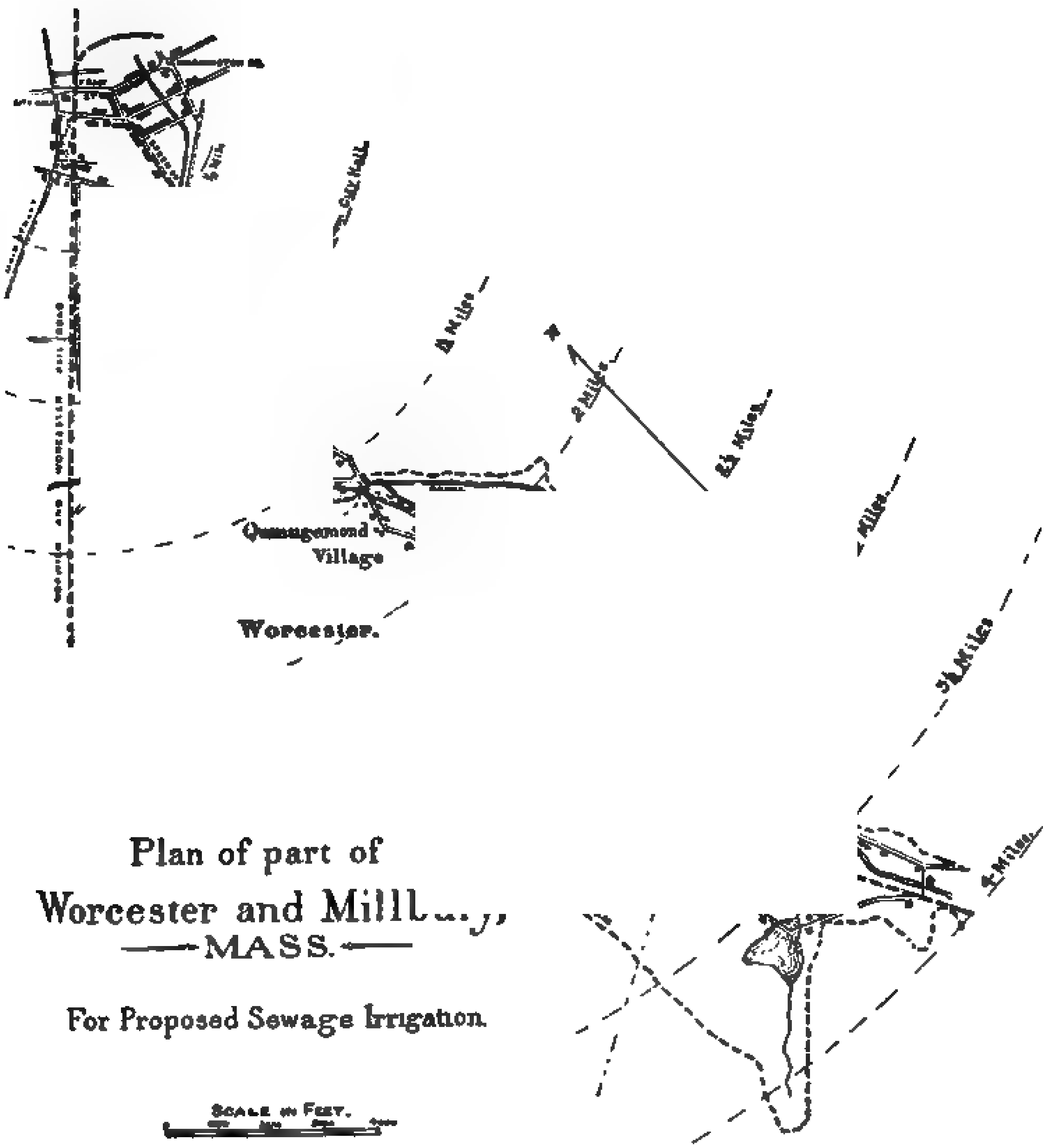
This process of irrigation seems the only practicable one for Worcester, and may be the best for Woburn. For the former city, Mr. Phinehas Ball, C. E., has proposed that the sewage be carried down three miles and utilized upon the loose gravelly land there. It could be distributed by gravitation, and there is so large an area of land that the sewage could probably be disposed of to advantage, even in wet seasons. Pumps and deep drains would not be needed. There certainly seems to be no place in the State where the experiment could be so fairly begun, and the present condition of the river calls for some remedy. We reproduce Mr. Ball's map,‡ with his permission. The area included within the dotted lines represents 840 acres, a very large part of which is available for sewage-irrigation by gravity-flow.

The sewage of Woburn could be well disposed of by Mr. Bailey Denton's system of intermittent downward filtration, combined with irrigation; or it might be carried out to deep water, but probably at greater expense.

* The average annual rainfall in most parts of England is about twenty-five inches; in some parts of the kingdom it is three times as great. In Massachusetts it may be said to be between forty and fifty inches. Our sewage is nearly twice as dilute as that of most English cities.

† See page 395.

‡ From a Report upon the Possibility of Utilizing the Sewage of the City of Worcester, 1873. See also Mr. Ball's letter upon the same subject in the Fourth Annual Report of the State Board of Health, pp. 109 *et seq.*


City Hall
2 Miles
2½ Miles
3½ Miles
4 Miles
Village
Worcester.
Plan of part of
Worcester and Mill
MASS.
For Proposed Sewage Irrigation
Scale in Feet.

The refuse from tanneries, which forms a large part of the Woburn sewage, is well adapted for irrigation, if diluted. After being purified, it might be discharged into the Lower Mystic Pond by an open brook. Russell Brook might be diverted to that point at slight expense.

Any discharge of sewage into Mystic Pond and into the upper part of Mystic River, can hardly fail to be a source of great offence.

Lake Cochituate is polluted, to a slight extent to be sure, by the refuse of Natick. Considering how little we know of the "germs" of disease, except that they retain their activity for a certain length of time, this must be looked upon as an ever-present danger, and should be met by legislative action. The town of Natick should be compelled to remedy the evil. If their sewage were purified by irrigation, it might perhaps pass into the Charles River without danger, and the water-supplies of Waltham, Newton, and Brookline might not be endangered, as they probably do not get their water chiefly from the river directly, but largely from deep springs or streams; but the Board do not desire to be understood as recommending such a plan.

In public institutions, prisons, asylums, etc., it is our opinion that the sewage can be utilized and purified by irrigation to great advantage, and this disposal of it should be made when the land can be got.

It is a matter of regret that there are not permanent boards of health in all our cities and towns, whose first duty it should be to give timely warning of any causes of danger to health.

The recommendations which we respectfully make are as follows:—

I. That no city or town shall be allowed to discharge sewage into any water-course or pond without first purifying it according to the best process at present known, and which consists in irrigation; provided, that this regulation do not apply to the discharge from sewers already built, unless water-supplies be thereby polluted; and provided, also, that any intended discharge of sewage can be shown to be at such a point or points that no nuisance will arise from it.

II. That no sewage of any kind, whether purified or not,

be allowed to enter any pond or stream used for domestic purposes.

III. That each water-basin should be regarded by itself in the preparation of plans of sewerage and water-supplies.

IV. That accurate topographical surveys be always made of all towns before introducing water-supplies or sewers.

V. That steps should be taken, by special legislation, based upon investigations and recommendations of experts, to meet cases of serious annoyance arising from defective arrangements for the disposal of sewage.

VI. That irrigation be adopted, at first experimentally, in those places where some process of purification of sewage is necessary; and that cities and towns be authorized by law to take such land as may be necessary for that purpose.

VII. That every city or town of over four thousand inhabitants be required by law to appoint a board of health, the members of which shall be required not to hold any other offices in the government of their city or town.

Finally, the Board feel that, in the present state of our knowledge, sweeping laws for the general and immediate purification of all our streams would be hardly justifiable, and that they are not called for by the present condition of our rivers.

They hope to continue their investigations during the present year, for which no special appropriation will be needed.

HENRY I. BOWDITCH,
ROBERT T. DAVIS,
RICHARD FROTHINGHAM,
DAVID L. WEBSTER,
JOHN C. HOADLEY,
THOMAS B. NEWHALL,
CHARLES F. FOLSOM,
Members of the State Board of Health

JAMES P. KIRKWOOD.
FREDERICK WINSOR.
WM. RIPLEY NICHOLS.

SANITARY HINTS.

By HENRY I. BOWDITCH,

Chairman of the Board.

SANITARY HINTS.

To the Massachusetts State Board of Health.

Gentlemen :—I have thought that the following facts, occurring within my own professional experience, might be suggestive to some readers of the importance of attention to hygienic law about their own dwellings.

It seems to me, also, that it is expedient to keep practical questions of sanitary law and work constantly before the people.

The first statement I shall make in regard to sanitary law, as manifested during an epidemic among horses, may seem to some minds irrelevant. According to my own views of the subject, the result, to which our investigation brought us, has always been a proof of the importance of fresh air, simple food, sufficient warmth, with absolute cleanliness, not only to horses, but to man.

I must add that I think the majority of householders of the present time grossly neglect one or the other of these matters, thereby incurring greater risk of bringing disease and death into their families, than it is possible to express by any numerical formula.

I.—Epidemic among Horses, and the Influence of bad Hygienic Conditions on the prevalence of it.

About thirty years ago an epidemic appeared among horses similar to, but much less severe than, that which more recently (1873) prevailed in Boston. Finding it very rife, I proposed to a class of young medical men to investigate its characteristic symptoms, and also to find out whether good, warm, and dry, well-lighted, well-ventilated, and clean stables were any more or less fortunate in the number of sick horses in them, than were those in circumstances exactly the reverse. I proposed this investigation because I supposed that valuable

information would probably be the result,—information that would be of service, not only to the animals,—at least in the subsequent treatment of them,—but also equally suggestive of hygienic law in reference to mankind. I argued as follows: The horse is one of the most careful animals we know of in the selection of his food. He uses virtually but one kind, and is very particular in his selection of that. All horses being submitted to the same kind, and nearly the same quality of food, we have an opportunity of deciding something of the effects of the surroundings of each; viz., of bad air and poor ventilation, of moisture or dryness, of light or darkness, of cleanliness or filth of their stables; and if we can find anything about these points in their influences on horses, surely we may infer something in regard to the influence of the same elements on men; because, in the grand features of respiration, digestion, and innervation, there is a great similarity between man and the horse.

Our party divided the city into certain districts, and each man inspected every stable in the district allotted to him. We obtained the number of horses in each stable, and the number of horses in each attacked by the epidemic, and, so far as was possible, the degree of severity of the disease in each stable. Moreover, we classified the stables in three categories, which might be named as follows:—

1. Excellent.
2. Imperfect.
3. Wholly unfit.

In the first we found excellent light, warmth, dryness, ventilation, and cleanliness. In the second, one or more of the above elements of health and comfort were wanting. In the third, there were none of these elements; for they were cellars, imperfectly lighted and warmed, very damp, and very dirty.

Having collected all the data, we tabulated the results.

The general—most pregnant—facts brought out by the analysis were indelibly impressed on my memory. I have acted upon them ever since. Under the influence of modern investigations in reference to "filth diseases," they will seem most reasonable.

The three chief results to which I have alluded were these :—

1. In the best,—viz., the warm, dry, well-lighted, well-ventilated and clean stables,—fewer horses were attacked, and the disease was milder.

2. In the vilest of the stables,—those wholly unfit for use; viz., those wanting in pure air, in light, warmth, dryness and cleanliness,—every horse was attacked, and more severe and more fatal cases occurred.

3. The stables wanting in one or two of the above qualities, though sufficiently good in the others, stood in an intermediate rank between the first and third in the number of horses attacked, and in the general characteristics of the disease. In fact, the three stood exactly in the following arithmetical proportion: Supposing 5 to represent the worst stables, in which all the horses were severely attacked, the others stood as 3 and 1. So that the numbers 5, 3, 1, since that investigation, have given to me the possible results of an epidemic of acute disease among horses under like circumstances. These results have been remembered, when watching the course of epidemics among human beings.

Cellars,—dark, damp, ill-lighted, and cold,—if used as houses, are the charnel-houses of our civilization, and are justly forbidden by law, although it is but too frequently violated in Massachusetts. These are representatives of our vilest classes of houses.

The neatly-kept, well-arranged, thoroughly-ventilated, well-drained, sunny homesteads on the hillsides of our country, can be made most wholesome in their influence upon the family. Any householder who foolishly *neglects* to provide for either of the above requisites for a house, either in city or country, tends just so far to bring disease and death into his family.

II.—Typhoid Fever in Massachusetts.

In the second report of this Board,—1871, p. 157,—it is stated :—

"One section of this town is, from some cause entirely unknown, very subject to typhoid fever." . . . "Local causes have been often sought for, but never found."

Dr. Derby and I visited the place, and carefully examined the spot, and learned the following facts (see cut) :—

In house No. 1, D. F. had lived many years without any marked illness in his family. In October, 1857, he removed to house No. 2, five hundred and forty-three feet from No. 1, and midway up the hill, at the foot of which No. 1 stood. The following year,—namely, in July and September, 1858,—seven cases of typhoid fever occurred in the family —the mother and six children. One of these last, it is true, did not live at the house, but was very frequently there. Subsequently, up to 1871, four domestics were attacked, and the mother had the same disease in three separate years, making in all fourteen cases, all but one in immediate residents of this house.

In house No. 3, P. P. F., son of D. F., had three cases in his family in 1868. He had his milk, and also drew water, from No. 2.

In house No. 4 resides D. B. He had milk from No. 2. Three of his children used it, and one of them had had fever a short time before our visit.

In house No. 5, occupied by T. F., 2d, nephew of D. F., three cases (1862, 1865 and 1871) had occurred. He had a cow, and used her milk. Got water in house 6, in which a fatal typhoid case had occurred, possibly contracted from milk procured from No. 2.

In house No. 6, of T. F., Sr., three cases had occurred. The house was built by the present occupant forty-two years ago. He never had fever in it till a year after D. F. built his house, No. 2,—namely, in 1862–63,—and he died of it in 1867. He got his milk from No. 2.

In house No. 7 lived W. B. F. One case occurred during the year after D. F. built No. 2, and from this latter he got milk.

In house No. 8, built forty-one years ago, resides M. M. F. In this had occurred six cases, commencing four years after No. 2 was built,—namely, two in 1861, four years after building of No. 2; one in 1868; one in 1872; and two in 1873. The last two cases had occurred in a family which had, only a few months before our visit, moved into a portion of the house. Mrs. F. had milk from No. 2; the last family had it from No. 7, or at times from the passing milkman.

This much may be further stated in regard to these houses

Plate 1.

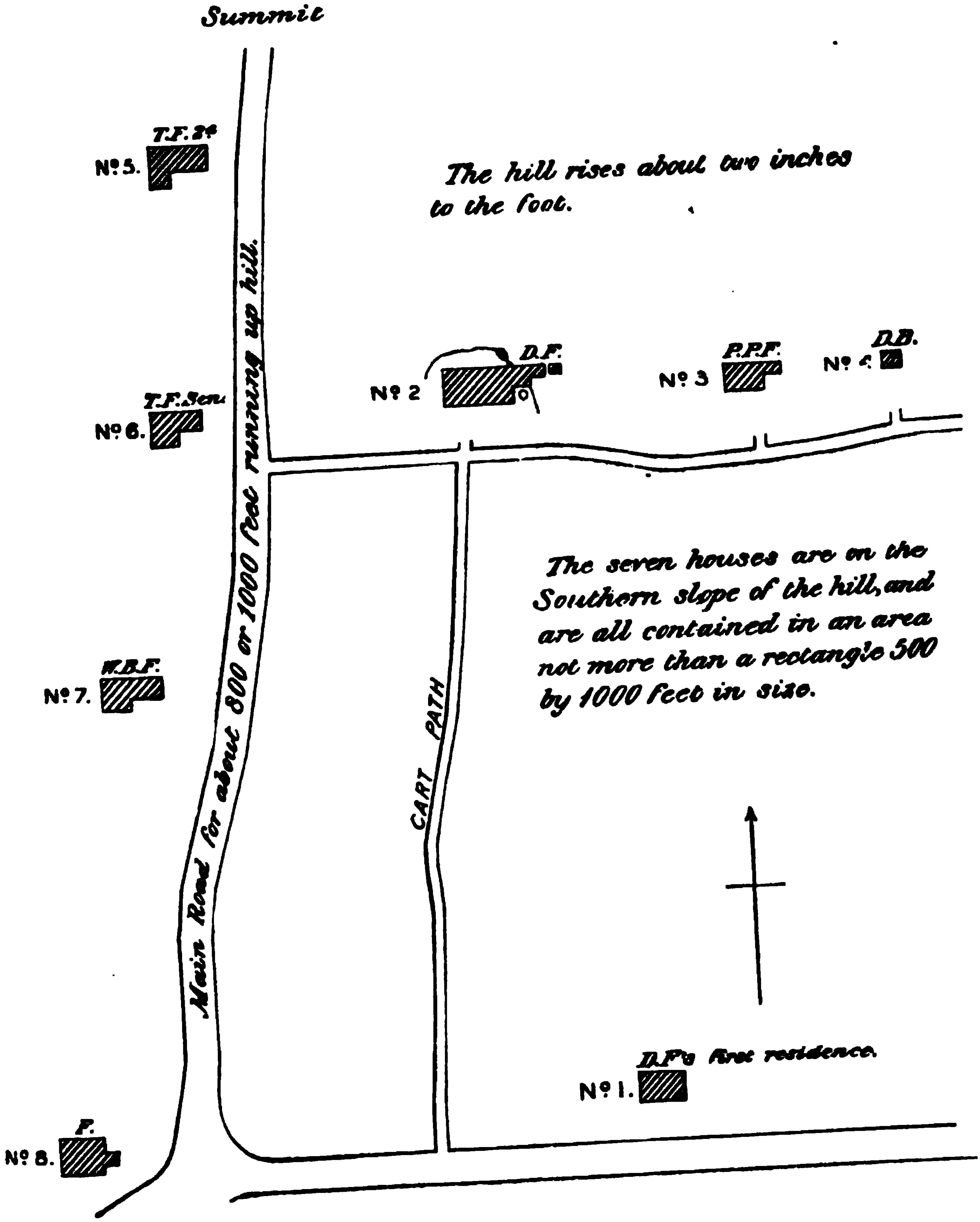

Summit
T.F. 2d
No. 5.
The hill rises about two inches to the foot.
D.F.
No. 2
P.P.F.
No. 3
D.B.
No. 4
T.F. Sen.
No. 6.
Main Road for about 800 or 1000 feet running up hill.
The seven houses are on the Southern slope of the hill, and are all contained in an area not more than a rectangle 500 by 1000 feet in size.
W.B.F.
No. 7.
CART PATH
D.F.'s first residence.
No. 1.
F.
No. 8.

Plate 2

ENLARGED REPRESENTATION OF THE PREMISES OF D.F.

and their occupants: All of the houses are on the same southern slope, and the residents, excepting D. B., in No. 4, are relatives, and in frequent intercourse. The ground is a gravelly loam, quite shallow, supported by a very hard clay pan,—so hard that, in digging holes, the heaviest blows with pick-axe are required to penetrate it. This pan, in fact, forms a vast smooth surface, over which all water-drainage would easily flow, unless where holes are made in it. The well at No. 2 is just one of those apertures always ready for the reception of slops or privy infiltrations. The following enlarged view of the house will show this more clearly:—

The following table will also give a clearer view of the relative connection of the various houses, than can be got from the text:—

House.	FAMILY.	Gets both milk and water from.	Milk only from.	Water only.	Number of cases of fever.
No. 2,	D. F.,	No. 2,	-	-	14
" 3,	P. P. F.,	No. 2,	-	-	3
" 4,	D. B.,	-	No. 2,	-	1
" 5,	T. F., 2d.,	-	-	Keeps a cow; has water from No. 6.	3
" 6,	T. F., Sr.,	-	No. 2,	-	3
" 7,	W. B. F.,	-	" 2,	-	1
" 8,	M. M. F.,	-	" 2,	-	4
	Mrs. F.,	-	From No. 5, or milkman.	-	2
					31

It will be seen from this table that every case of typhoid fever may have been, either directly or indirectly, caused by connection with No. 2. My reasons for making this suggestion (for I admit that it is not proven, and I doubt whether it is possible in such a case to present strictly mathematical proof) are these:—

It is well known from many, and especially from English investigators, that polluted water and milk may cause typhoid fever. Now, we must grant that house No. 2 has had all the requisites necessary for contamination of its well-water, and

indirectly or directly of the milk kept there. A glance at the plate proves this. Twenty-six out of the thirty-one cases were provided with either milk or water from this No. 2. Seventeen of these had both milk and water. Of the five remaining, three of them, at house No. 5, got water from No. 6, which itself got its milk from No. 2, and the two others got it at times from No. 5, where fatal typhoid had prevailed. A chemical examination of the well-water from house No. 2 revealed a certain though small amount of drainage.

But whether all these cases have arisen from No. 2 or not, the decision of sanitary law in regard to the wretched arrangements in that house, for the carrying away of its slops, and the dangers of contaminated well-water from them and the privy, would be certainly decisive against its healthfulness. It is such an imperfect arrangement as this which at times sends disease and death into our houses. A year or two since, at Mt. Desert, similar arrangements spread typhoid fever among a large number of its visitors at the chief sea-side hotel.

A thoroughly just decision would be that a well, situated as that at No. 2 is,—viz., lower on a hill than its drains and privies are,—is in a dangerous position, and, therefore, should be given up, and another sunk far from any source of contamination. If that cannot be done, the next alternative is to have all slops conveyed away by perfectly tight-tiled drains, without being left to contaminate all the surrounding ground. The privy, also, at No. 2 should have small, tightly-cemented compartments made, and earth, ashes, charcoal or other disinfectant should be thrown down daily, or, still better, thrown by each occupant of the premises immediately after leaving any refuse. All this refuse should be every few days removed and composted. Until this be done, D. F. ought to cease to allow either water or milk to be used from his premises. This was my advice two years since. I learn that it has not been followed, and, although typhoid fever has not prevailed in the locality the past two seasons, experience teaches that it is wrong to expect any long immunity from it while such conditions last. At some future time, when the people have become sufficiently educated, such a nuisance will not be allowed openly to remain a single day. Under the recent

advanced laws of England it could not now exist, unless the administrators of the law were grossly neglectful of duty.

III.—Disease and Death in a Family apparently consequent upon well-intentioned Changes in a Home stead, but which were made without due regard to Sanitary Law.

Erysipelas, spinal meningitis, scarlatina, rheumatism, with sore throat, tonsilitis, fatal pericarditis with convulsions, typhoidal pneumonia,—all occurring in one family between December and the following June. Ill-arrangements of the house, defective drainage, sewage-obstruction, dampness of the cellar,—all probable factors in these diseases. Suggested improvements.

July 3, 1875, I was requested to examine a certain homestead, of which the following data were given.

The house is a fine, old-fashioned, square wooden building, midway up on a southern slope of a hill, in a thickly-settled town adjacent to Boston. All the arrangements were spacious in and around the dwelling. A large hall traversed the centre of the building, from lower floor to the garret, giving ample space for air-circulation. The soil about and above it, towards the brow of the hill, was rather damp. The house had been built by the grandfather of the present occupant, and no special liability to illness was observed on the part of the residents therein, until the time to be hereafter noticed. The cellar was not cemented, and was very damp. Across the north-eastern corner, and under the house, for the space of about twenty feet, was a drain for kitchen-slops, and for water-closet contents. The latter were first introduced into the house twenty-five years ago, apparently without evil results. The present occupant, grandson of the builder, married six years ago, and lived elsewhere, until October 1, 1873, when he came into possession of the estate. He had four children, who had been healthy. Before removing his family to the homestead, he thoroughly repaired and made very material, and, as I think, very pernicious, changes in the house. The family was in the country, and well, until August, 1874.

In the autumn, they returned to the newly-arranged homestead. It was heated throughout by means of a furnace. No special effort was made to keep it either well or ill ventilated.

The disease-record that ensued, is as follows :—

Case 1. In December, 1874, four months after the removal, the nurse of the children was taken with severe erysipelas of the head. She was ill four weeks, and recovered.

Case 2. In January, 1875, the youngest child became quite ill with spinal meningitis. She gradually recovered, after many weeks.

Case 3. While the preceding was ill, her two younger sisters were taken with scarlatina, about February 1. They were ill three weeks, and both recovered.

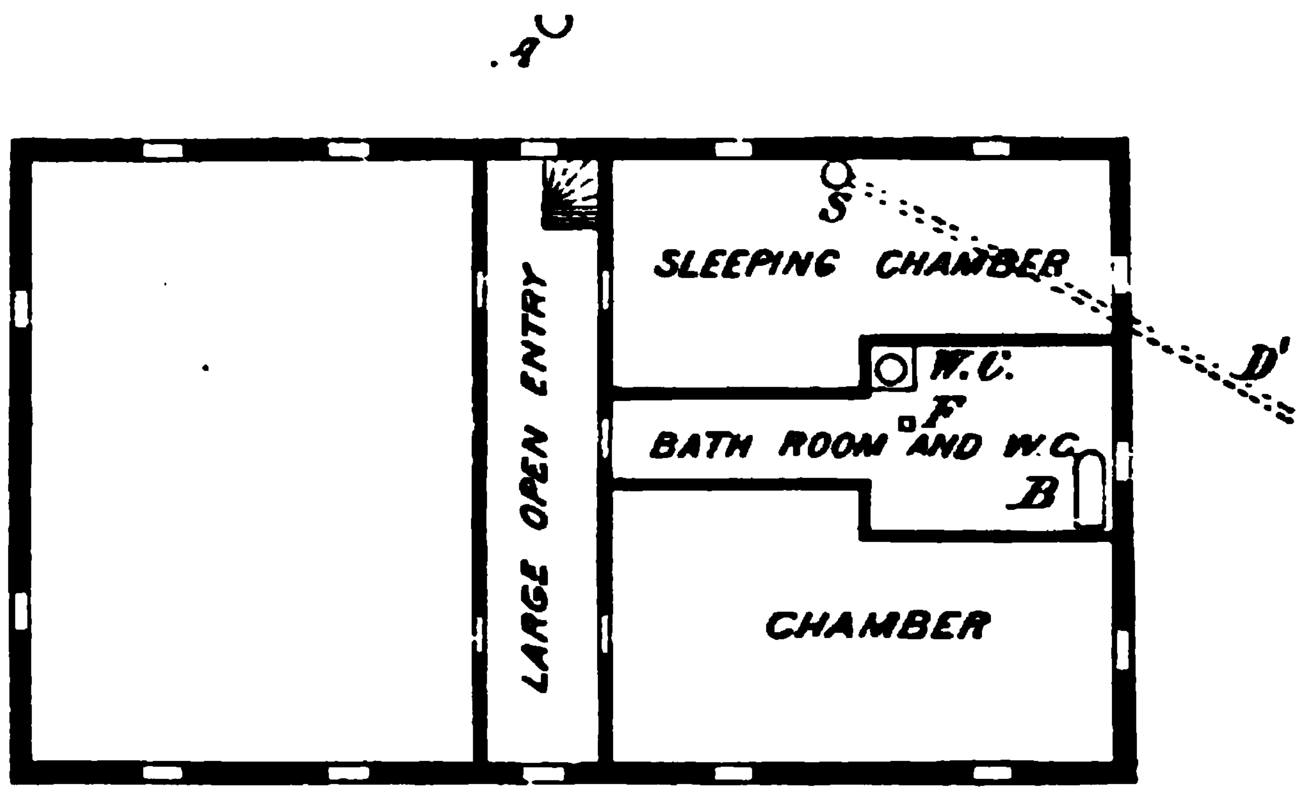
Case 4. The mother, worn down by long attendance upon her children, had soon afterwards severe rheumatism, with sore throat. She was ill three weeks, and confined to her bed most of the time.

Case 5. May 1, one of the children, originally attacked with spinal meningitis, was taken with severe tonsilitis, but was not thought to be very ill, although feverish. She was supposed to be getting well when she died suddenly in convulsions. At the autopsy, it was found to have been a case of acute latent pericarditis (inflammation of the heart-sac).

Case 6. This was one to which I was summoned in consequence of her being affected with some acute pulmonary disease. I found her a weak, puny, apparently prostrated child. The physical signs were scarcely perceptible, and indicated the most trifling pneumonia at the lower part of the left lung. Evidently something beside that was weighing down the child. Having heard the above facts, and looked at the premises, I advised her immediate removal. This was done soon afterward, and the patient slowly recovered.

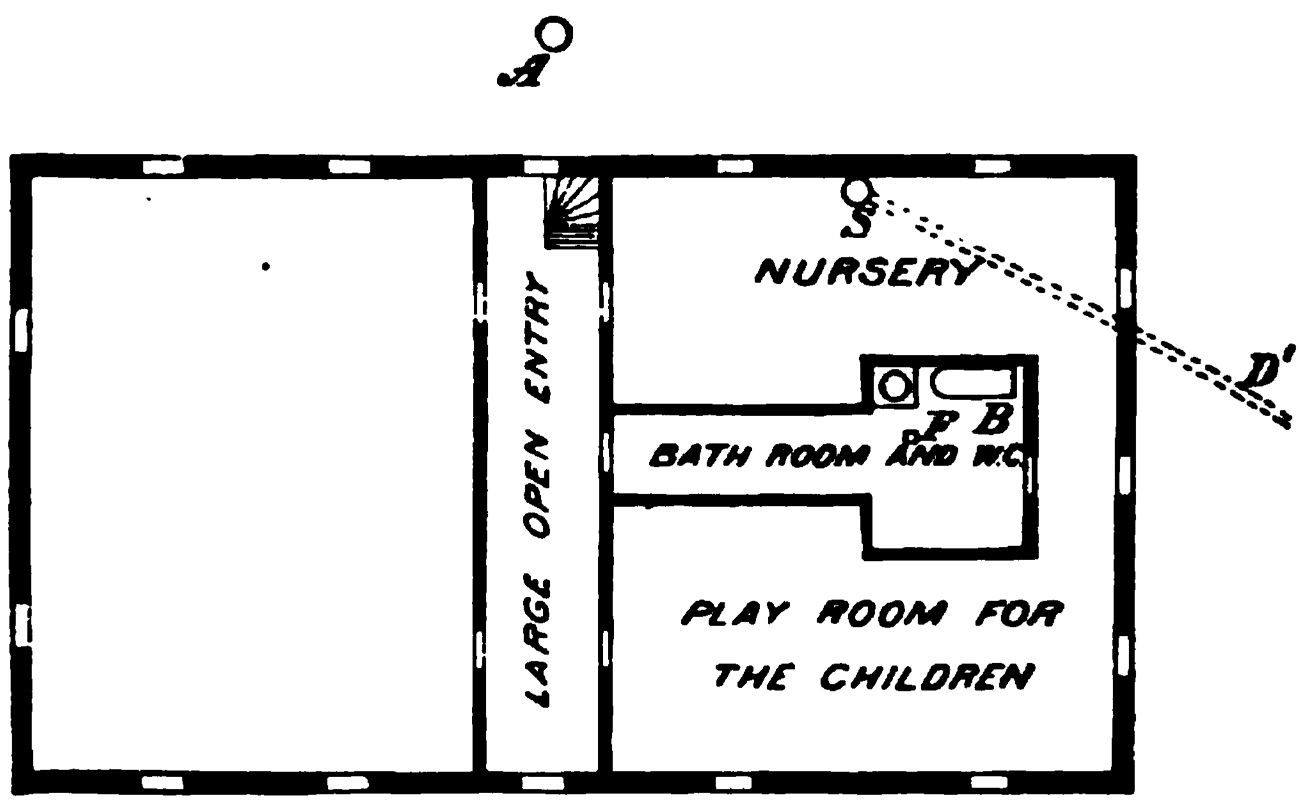
It may still further be remarked, as possibly the result of the residence, that the father, though always liable to some throat irritation, had been during the autumn and winter peculiarly annoyed by it. No one of the family, in fact, escaped from some illness, and yet they had been healthy previously to living there. The attending physician had become convinced that "something wrong existed about the house," and had advised a sanitary inspection of the premises. He

No 1.



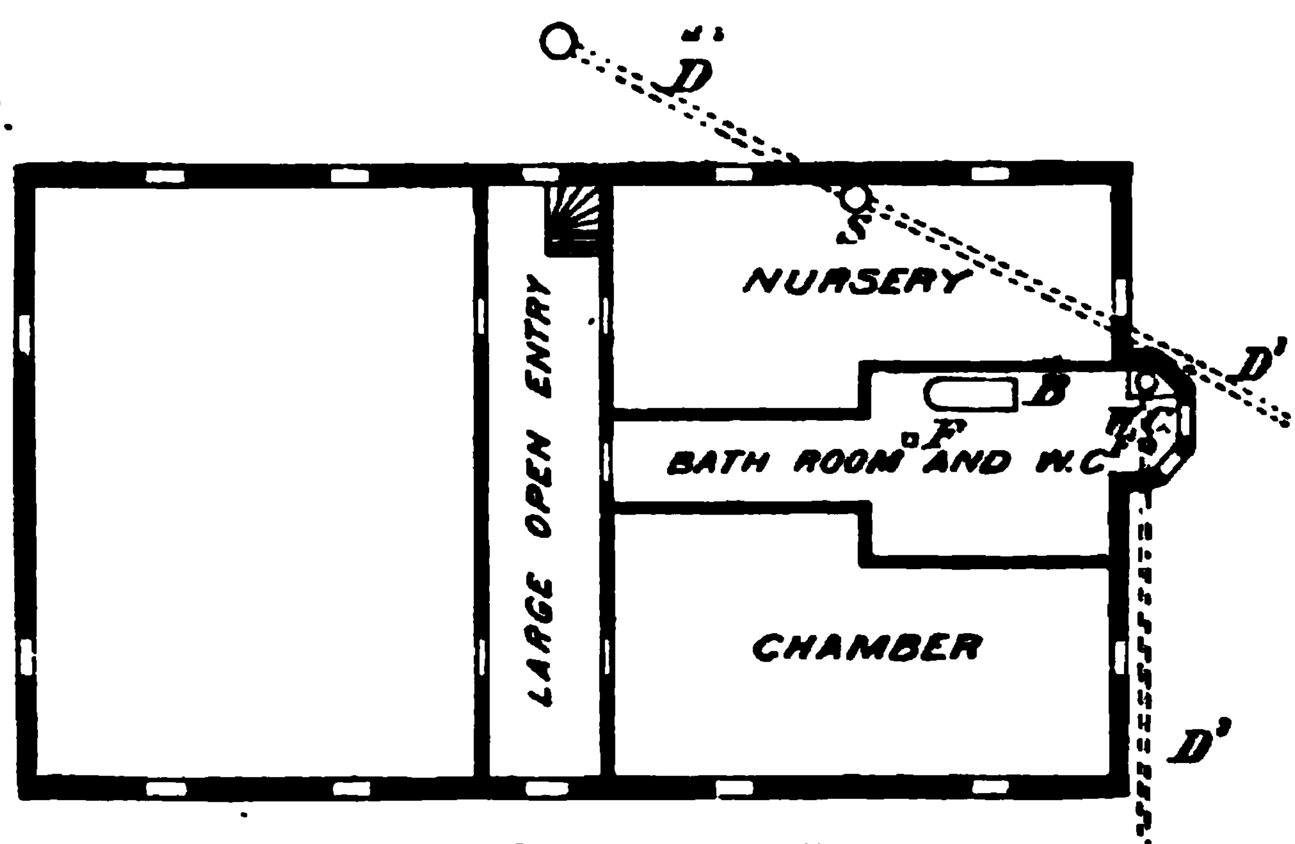
PLAN BEFORE 1873.

No 2.



PLAN AFTER 1873.

No 3.



PROPOSED PLAN IN 1875.

had made suggestions almost, if not quite, identical with those subsequently given by myself to the occupants of the house.

Let us, now, view the premises, and decide what influence, if any, they may have had upon the mass of disease which had fallen upon this unfortunate family, within a short time after taking charge of them. In order to make the subject more clear, I present the following diagrams* which may be described as follows:—

No. 1. The premises, as they had been for twenty-five years, before 1873.

No. 2. The same modified by the present occupant, in 1873.

No. 3. The same, if altered according to plans suggested by the examination.

All the diagrams represent the second floor of a large, square house, with sleeping-chambers, and bath-room, and watercloset, opening into a long entry which passes from the front to the rear of the building, thus, as stated above, allowing a very full circulation of air.

No. 1 provides that the bath-room and water-closet should be entirely separated from the two sleeping-rooms adjacent. Entrance to the two former was only by a door in the entry. A window opening on the side of the house, and a ventilator to the chimney from the water-closet, gave sufficient opportunities for the escape of deleterious gases, without contamination of the residents.

For twenty-five years these arrangements had existed, and no apparent trouble had arisen. In 1873, the grandson took possession of the house, thoroughly repairing and altering it, and in so doing—1. He shut off the water-closet, seen in plan 2, from the open window: 2. He opened a passage between the two adjacent chambers, and thus brought them into immediate contact with sewer-gases, by means of a door communi-

* The following is an explanation of the diagrams: A, a shallow hole, a few inches deep, with an iron strainer, making it look like opening to a drain. The surface of the brick-covered yard was so arranged as to convey into this aperture all the water falling upon the yard, and much from the hill above. S—Passage for kitchen-slops, and leading to D^1. D^1, a common, small, brick drain into which kitchen-slops and water-closet contents were carried. F—Furnace-flue, W C—Water-closet. B—Bath-tub. D (diagram 3)—New drain communicating with and tending to wash out out D^1. D^2—Proposed new drain for water-closet, and to be carried wholly outside of the house.

cating with this passage-way and water-closet: 3. By this arrangement the passage-way, connected with the bath-room and water-closet, became part of the playground for the children, and the door being frequently open, it would obviously be almost, if not quite, impossible to prevent contamination of the sleeping and waking hours of the children and of their attendant nurse. The latter, it will be remembered, was first taken ill; then came all the children and mother, successively, one of the former dying. The father had an irritation of his throat.

Now, under the light of modern sanitary investigations, I have no doubt that this arrangement was the main factor in these terrible results. But this was not all. The cellar was very damp; ashes that had been put in a brick apartment in one corner of it became a moist, decomposing mass.

This dampness was increased by the supposed drain A in the yard. This was found to be nothing but a shallow *cul-de-sac*, about a foot deep, into which all the water from the brick-covered yard, and much from the hill above, was caught, and afterwards allowed to soak down along the outside walls of the cellar, thus increasing the natural dampness of the earth near by. Moreover, I found a slop-drain at S, connected with the kitchen, running into the drain S D. Into this drain had been also introduced the soil-pipe of the water-closet. On opening the drain it was found clogged with fecal matter. Here, then, were no less than three more distinct sources of ill-health. First, natural moisture of the soil about the cellar; second, the *cul-de-sac* above named increasing that moisture; and finally, third, the fecal obstructions.

The following changes were suggested (*vide* third diagram):

1st. Shut up the passage-way between the two chambers.

2d. Carry the water-closet fairly outside of the building into a bay window rising from the ground to the ceiling of the second story. Keep it warm by furnace-flues carried into it. Have two windows in it, and also ventilate it by a pipe carried up to the top of the house. Carry the soil-pipe into a new drain on the outside of the house at D^2, and thence, by a very rapid descent, into the street drain below.

3d. Build a new drain, D, from A down into D^1, to meet t S. This surface-water, thus diverted from the

cellar wall, would at times cleanse the drain, and
times ventilate it.

4th. The cellar should be dug out, and at least a
clean gravel laid over the whole surface, and a stron
cement covered over that up to a level with the surfac
ground outside of the foundations of the house. The
should be similarly cemented, and its bottom made tig

5th. We advised a thorough cleansing of the ro
which scarlet fever had occurred.

I trust, gentlemen, that these facts of disease, thus d
even if our counsel be not all that could be wished f
be as suggestive to others as they have been to myself

I remain, faithfully,
Your friend and colleague,

HENRY I. BOWDI

NOTE.—March 1, 1876. The above recommen
given by the family physician and myself, have been,
tain respects, more than carried out. All the soaked
earth * was removed from the cellar to the depth of tw
and after disinfecting the surface thus exposed, a l
gravel and cement four inches thick was laid u
Thorough dryness of the earth is provided for by a
drain run around the inside of the cellar walls, with a
ing into a drain outside. The water-closet and slop
S and D[1], are removed. The former is put in the b
dow outside of the house, with thorough ventilation by
of two shafts, one to the top of the house and the oth
a kitchen flue, always kept warm. The water-closet
windows in it, and has no connection with the house
by a door, usually kept shut. The slop-drain (S) is
strong iron pipe, hung from the ceiling of the cell
carried thence into a well-trapped and ventilated drai

* The earth, when removed from the cellar, was so very offensive
air was filled for some distance around it with a vile odor, distr
the neighbors.

yard. I regret that the passage-way leading between the chambers has been retained; but as the water-closet door is kept closed, and the closet is out of the building, and so perfectly ventilated, little evil is likely to arise. The family is not constantly, as before, *necessarily* exposed to sewer-emanations. Since the recovery of the last-named patient, in June last, all have been in perfect health, except that the father has had a slight rheumatism; not enough, however, to prevent attention to business. Of course, all parties feel gratified at the result.

HOUSE-DRAINAGE.

The following is written for the latitude and climate of Massachusetts.

It is not the purpose of this paper to prove the necessity of removing fecal matter promptly from our houses. This may be assumed as already proven. The intention is rather to point out how, in our community and under existing conditions, it can best be done. Neither does it seem worth while now to discuss the relative merits of the various systems by which this removal is accomplished in different places. Volumes have been written on this branch of the subject, and new schemes are constantly under trial. But the experience of all the large towns in this country, as well as that of most large European towns for the past ten or fifteen years, indicates the water-closet system for the removal of fecal matter, and the uniting with this of the refuse of kitchen sinks, for removal by water carriage through a system of drains and sewers to a destination suited to the locality, as best adapted to meet the wants of our people. It is, on the whole, likely to be attended with less difficulty in its details, and more efficiency when applied to all sorts of houses and all classes of population, than any other system of removal yet devised.* At any rate, this system has had a very

Limit of subject to be discussed.

Water-carriage system an established custom.

* Menzies, in his "Treatise on the Sanitary Management and Utilization of Sewage," page 8, says: "Looking at the question in all its bearings, I am forced to the conclusion that the water-closet system will supersede all others, while I believe that I shall be able to show that, agriculturally speaking, it is the best and most profitable."

Baldwin Latham, in his "Sanitary Engineering," page 328, says: "A good water-closet is the only appliance fit to be used within a house, for by it all matters are at once conveyed away, and cease to have the power of producing evil, so far as our houses are concerned. It is not so, however, with those systems which conserve fecal deposits within, or in close proximity to our dwellings, as there is always danger in storing a dangerous article, however carefully we may tend and guard against its evil effects."

Mr. Simon, in his report as medical officer of the Privy Council and Local

extensive application, and is widely popular. Until something better is devised, and has had the test of time to prove its worth, this will continue to be used. It has its weak points, however, and much remains to be done towards avoiding the dangers incident to its mismanagement, and towards perfecting its details. It behooves us, also, to seek to adapt it to the conditions existing in our community in the simplest and most efficient manner, so that they can be understood by any one who owns a house, or hires one.

Defects to be pointed out.

Drains between the House and Sewer or other Receptacle.

Drains outside the house.

The prime object of house-drainage is the removal of the refuse with all possible speed. Every device by which any part of it is hoarded or retarded in or about the premises is to be carefully avoided. Hence, cesspools are an abomination.* Wherever sewers exist, they are worse than needless. The only excuse for any sort of cesspool near a house is the need of separating grease from kitchen-drains. Small, tight, brick tanks, or stoneware grease-pots, seem to be a necessary evil among a population who waste, or whose servants waste, so much fatty matter in their kitchen-sinks as ours. The best way to provide for this will be described later.

Cesspools objectionable.

Essential conditions.

To secure a prompt and continuous flow, drains must be smooth inside, must be well laid, of a proper size, and have sufficient slope to render them self-cleansing. Where the last is not practicable, there should be provision for frequent flushing. They should also be as nearly impervious as pos-

Government Board, London, 1874, says: "The advantages of the water-closet system, where it can be adopted, and will be properly worked, are, as regards the extremely important object of getting the refuse continuously and completely removed, too evident to require advocacy. Those advantages, however, may fail to be realized if the system be adopted without due circumspection; and the conditions which ought to be kept in view in order to avoid any such failure are, apparently, these three: First, that the closets will universally receive an unfailing sufficiency of water properly supplied them; secondly, that the comparatively large volume of sewage which the system produces can be, in all respects, satisfactorily disposed of; and thirdly, that on all premises which the system brings into connection with the common sewers, the construction and keeping of the closets and other drainage relations will be subject to skilled direction and control."

* See Menzies' Treatise, page 20.

Best material.

sible, to avoid contaminating the surrounding soil. For house-drains, no material is so good as cast-iron, with calked lead joints. But glazed stoneware pipes, carefully put together with hydraulic cement, will make very good drains outside the house walls, if the soil is firm and not liable to settle. There is much of it made in this country; but it is mostly inferior in strength to the Scotch or English, which is imported at slightly higher rates. Their connections or branches should never be at right angles, but oblique, so that T-joints or branches should never be used. They always tend to produce an accumulation of solid matter. Y-joints or branches can always be obtained (see Fig. 1 and 2), and the position of the drain can generally be adapted to their use by taking a little pains. When being laid, a swab should always be drawn through them, to wipe the surplus cement from the joint on the inside, every new piece put into the trench being strung on to the line or rattan which carries the swab, and draws it along. The writer has seen a good drain, which would otherwise have been successful, entirely choked by sewage accumulating against those burrs of cement inside the joints, which should have been wiped out when laid. Col. Waring recommends a hemp gasket at the joint, to prevent the cement from running through, but this cannot be applied without shortening the joint to some extent, and thereby impairing its tightness. The lap is never very long, at best, and cement is never so sure of stopping water as when its surface is wiped, while fresh, on the side where the water seeks to enter it.*

Connections.

Y branches.

FIG. 1.—T-joint in Drain.

Inside joints.

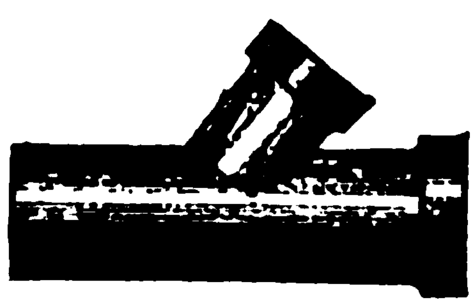


FIG. 2.—Y-joint.

Drains often too large.

A frequent mistake is made in laying too large-sized pipes for drains, arising from the notion that small pipes are more likely to be choked. The fact is, that all increase of size above the requirements of capacity is an actual injury, by diminishing the scouring power of the current; so that, if laid

* A gasket, carefully applied, would tend to hold the ends concentric, and insure a continuity of the interior lines, but it should be applied with skill, and in limited quantity.

with a fall of two feet or more in a hundred feet of length, a four-inch pipe is better than a larger one for a house-drain used by some fifty persons, because, with this limited flow, the small one would scour better than the larger one. If rain-water is admitted from the roof-gutters, either for convenience or flushing, a larger size is perhaps needed, but six inches is ample, even then, for any ordinary house-roof. If the fall is less than two per hundred, flushing may be needed. Latham says that, in order to be self-cleansing, the house-drain should convey its contents at the rate of three feet per second. To attain this velocity, a four-inch drain must have a fall of about one in a hundred, and a six-inch drain must have a fall of about one in a hundred and forty, even when half-full. As such drains seldom run half-full, they cannot be relied upon as self-cleansing, unless laid with nearly double the above rate of slope,—say two per hundred for four-inch drains, or one and a half per hundred for six-inch drains. For hotels and large establishments containing many receptacles for sewage and many branch drains, a six-inch pipe would be ample, unless rain-water be admitted from extensive roof-surfaces. In this case the size of the drain is governed—first, by its rate of fall, which is generally limited by local topography; and second, by the size of the roof to be drained. In our climate, a rainfall of at least one and a half inches per hour from the roof-surface should be provided for, adjusting the size of the drain to carry this rainfall. In such cases, the sewage can be practically ignored, for its volume is quite insignificant in comparison with that of the rain-water. The problem then becomes a question of hydraulics, and reference must be had to the governing elements and well-known physical laws, thence computing the required size.

Size of drains.

When used for rain-water, this governs the size.

Drains are not intended to carry broken crockery, old clothing, rags or shoes. Such things are often found in them, it is true; but increasing the size of the drain is no remedy for such abuse, which would choke a street sewer. On the other hand, the smaller the drain which will carry the largest flow with which it is likely to be taxed, the better is the scour, and the more likely it is to keep clean. Any accumulation of sewage in the pipes is sure to decompose and give rise to abundance of poisonous gas, which it is next to impos-

sible to keep out of our houses. It cannot be expected that the interior of sewers and drains should always be free from such gases, but it is by all means desirable to reduce their volume to a minimum, and then to apply all possible precautions to prevent their mixing with the air we breathe. To prevent their access to our houses, traps are used. To a certain extent, and in certain places, they are essential, but there may be too many traps. Every trap in the line of a waste or soil pipe is necessarily a place for sewage to be arrested temporarily, and, if the use of the pipe be not very frequent, decomposition occurs, evolving gases.

Sewer-gases to be shut out and diminished in volume.

Traps.

In all houses draining into sewers, the place where a trap is most essential is outside of the house walls, on the main house-drain, after it has collected all the branches which are tributary to it, and between this point and the sewer. Prof. Edmund Parkes, in his treatise on practical hygiene, says, page 343: "It is hardly possible to insist too much on the importance of this rule of disconnection between the house-pipes and outside drains. Late events [supposed to be the illness of the Prince of Wales] have shown what a risk the richer classes of this country now run, who not only bring the sewers into their houses, but multiply water-closets, and even put them close to bedrooms. The simple plan of disconnection, if properly done, would insure them against the otherwise certain danger of sewer air entering the house. Houses which have for years been a nuisance from persistent smells, have been purified and become healthy by this means." The medical officer of the Privy Council, London, says: "This condition ought to be insisted on: that every private drain be properly trapped and ventilated in relation to the common sewers," etc. (Report of 1874, p. 32.)

In England and other places having a mild climate, it is usual to disconnect the house-drains from the street sewers by providing that the former should discharge their contents into a chamber or tank, open at the top, just outside the house walls, into which the rain-water spouts are often turned. The rigor of our New England winter prevents our people from following many of the devices which in Old England are quite efficient, and this one among others. All out-of-door drains are here of necessity kept deep in the ground, with as little

Traps between house and sewers.

exposure as possible to a temperature of 40° Fahrenheit below freezing, which sometimes prevails for several successive days.* The best sort of disconnection we can apply, is to introduce a pipe-trap between the house and the sewer. This should not be a built chamber with square corners, which might collect solid matter, but a mere depression in the pipe itself, having the same sectional area as the pipe, and therefore containing the minimum of matter for decomposition. (See fig. 3.)

Fig. 3.—Trap for Drain.

Such traps may sometimes be forced by the compression of air in the street sewers, especially if these are tide-locked

Fig. 4.

Vents for outside traps.

at high water, like many of those in Boston. To provide against this, a vent-pipe, of four inches diameter at least, should in cities be led from the hole in the trap directly up the side of the house, like a water conductor, and above all dormer windows. The water conductor itself will not answer for this purpose, for the compression of air in the sewer is most likely to occur during a heavy rain, when the water-spouts are fully occupied as such, and are, therefore, incapable of giving vent to the gas, for which special outlet must

* At the moment of writing this, November 30, 1875, the thermometer has averaged only two degrees above zero, Fahrenheit, for the past twenty-four hours, with a gale of wind from the north-west, forcing the air into every crack and cranny of our houses.

be given. In suburban districts, a vent into a pile of loose stones, or a man-hole chamber under ground will answer. (See fig. 4.) During the winter this chamber may be filled with dry leaves, etc., and the vent covered with wire netting, in order to prevent freezing.

A perfectly ventilated system of sewers would doubtless render this vent-pipe needless; but few of our towns, if any, have attained this stage of perfection in this respect. The method of sewer-ventilation advocated by Baldwin Latham, and largely practised in England, and by J. H. Shedd in this country, consists of small holes in the man-hole covers in the streets. In our climate, such vents are completely sealed by ice or frozen mud for six months, and perhaps by liquid mud and dust for a large part of the other six, unless cared for by men kept for the purpose. Sewer-ventilation generally imperfect.

The subject of cesspools has been alluded to above. Even where no street sewers exist, the cesspool may sometimes be dispensed with. Col. George E. Waring, Jr., in a series of excellent articles lately published in the "Atlantic Monthly," tells of his own experience in distributing his sewage through the soil of his lawn by porous pipes, serving to utilize the material in the simplest and cheapest manner. The writer has pursued a similar plan for over twenty years successfully. But many people have too little land about their houses to provide even this small "sewage farm" within their own limits.

The cesspool, then, in the absence of sewers, becomes a necessity, and large numbers of our people are thus driven, by the increase of poulation, to live on quarter-acre lots, and even smaller ones, with their old privy-vaults, cesspools and wells for drinking-water within one or two rods of one another! The habits of our people demand all "modern conveniences" inside their houses. They ask for water-supply and waste-pipes in all directions, and upon every floor; but if dependent upon wells for their drinking-water, these sources are sure to become sinks in the course of time. Neither can they expect any warning, appreciable by the senses. The change is insensible and invisible. The well-water may look as pure as ever, and taste as cool and refreshing, and yet contain the seeds of disease. Some argue Poisoning of wells.

that because their cesspool is on lower ground than the well, the latter cannot be affected, for, say they, "the dirty water can't run up hill." They forget that the contents of the cesspool may be twenty or thirty feet higher than the bottom of their well, from which they generally get their supply, and that although underground drainage, which supplies the well, generally runs in a direction indicated by the slope of the surface, there is no certainty about its always being so. There are times when the well-springs are low, and but little water is found in them. How do they know, then, that the cesspool, though in ground lower than the top of the well, may not soak in the direction of the well, whose bottom, nearly empty, is many feet below it? If the soil be once polluted about the house below the absorbing powers of surface vegetation, whose roots seldom go deeper than one or two feet, it never can be relied upon again with safety for the filtration of water for drinking.

The accumulation of filth in the soil around these porous cesspools is just as certain as the annual rise of the streams after the winter rains, and such accumulation is as certain to be followed by injurious effects upon the health of people whose houses are near such influences, as is any other violation of sanitary laws. It is said to be the invention of the shirt that brought us immunity from the plague, through the improved cleanliness of the skin. But if our people go on as they have done to pollute the soil about their houses by using water, as they now do, to dissolve their filth, rinse it out of their houses, and soak it down into their soil, the most frequent changes of linen will not save them. They must invent some other source for their drinking-water, than to pump it up again from the same soil, or the plagues of the East will visit us again in some form or other.

Sewerage imperative with an abundant water-supply.

SEWERAGE should follow immediately, or be provided simultaneously with water-supply. For, if wells are abandoned, and aqueduct water is to be substituted, the consumption of water is multiplied at once, and cesspools become quite inadequate to dispose of the house-washings. If sewerage is not provided simultaneously with a water-supply, the surroundings of our houses soon become saturated with water as well as filth, and steam up, under our July suns, to infect

our systems, through the lungs instead of the stomach, with consequences quite as fatal, and probably more speedy.

The details of the construction of sewers, and the ultimate disposition of the sewage, are subjects demanding a separate study for each new locality, and their investigation would be beyond the limits of this paper. No branch of civil engineering is more important, or more fraught with difficulties demanding skill and a careful study of the experience of others. It is, in fact, one of the most important questions connected with the growth of our modern civilization. No community can afford to ignore it.

Drains laid in filled land.

Trouble often arises from the settling and breaking of house-drains, when laid upon filled land. The books say that they must be laid in "virgin soil." It might puzzle the wisest to find any soil to answer that description among the many thousand houses built upon pile foundations in Boston and its suburbs. The occupants of such houses at the South End of the city, and in the fine mansions on the "Back Bay" have had a good deal of trouble from this source. In fact, it must exist, in some degree, over the greater part of wards 7, 8, 9, 10, and 11 (old divisions). The houses being built and occupied long before the mud bottom under the filled streets has become thoroughly settled, this process of settling continues in some places for years, carrying down with it the house-drains, which are inevitably sheared off near the outside of the house walls, for these are built on rigid foundations. The immediate consequence is a leak in the drain close to the outside of the cellar wall, and in some cases, entire breach of continuity.

Broken drains.

If leaking alone, the only warning received by the occupant of the house is in the percolation of the sewage through the wall or up through the cellar floor, for there is not one wall in five hundred that will stop it. Neither will concreting cellar bottoms stop it. The more resistance there is offered to the influx by such walls and floors, the more the filth is accumulated in the surrounding soil by lapse of time and constant leakage from the cracked drain, till the clean, porous gravel with which the street was once filled becomes saturated with the sewage, a sponge of an uncertain extent, filled with the foulest of matter, which it is next to impossible

to shut out of the cellars, for it is both fluid and gaseous, and penetrates the minutest pores.

Remedies. The remedy for this nuisance is by no means simple. Wooden boxes are slightly pliable, and, if made with care, and well clamped, may answer sometimes for temporary house-drains, till the material under the street has ceased settling; but even wooden boxes cannot be bent far without opening joints and becoming leaky. If houses must be built and occupied in such places, the only sure way of constructing a permanently tight house-drain would be to drive a row of piles for its foundation, between the house and the sewer. Even then, if the sewer is not built upon piles,—and they rarely are,—the break would occur where the piles cease, for nothing else is rigid over the compressible mud of these regions. This evil is so widely prevalent, that great complaint has arisen about the drainage of those districts, the source of which is more likely to be traceable to cracked house-drains, than to any defects in the sewers themselves. It is certainly a serious matter for any one who contemplates living upon newly-filled lands. The use of cast-iron drain-pipe all the way to the sewer, with calked lead joints, is recommended by some authorities, in soils subject to settling. But even iron pipes will break, if rigidly connected, about as soon as stoneware, though, having fewer joints, they may break in fewer places. They are certainly no sure remedy for this evil. If a tight, flexible pipe could be made, it might answer the purpose for awhile, but such a thing is yet to be invented in a permanent form.*

Man-holes for access recommended. A commission recently appointed by the city government of Boston to consider the drainage of that city, recommend making a man-hole for access to the house-drain close to the outside of the house wall, so as to allow of ready inspection for detection and mending of leaks, caused by settlement of newly-filled lands. This is an excellent suggestion, and if the leaks were confined to this point, would help the case materially. This point is the one where settlement is most likely to occur, and it may cover the whole trouble in a

* A flexible drain-pipe, made by coupling short joints of iron with rubber gaskets, if carefully put together, might answer for a number of years, but any packing of such organic matter is subject to decay, and then leakage occurs.

majority of cases, *if* well watched. Of course, it would need protection from frost in exposed situations. This could readily be given by filling the man-hole chamber with straw or litter.

Where a "virgin soil" exists, there is, of course, no excuse for the breaking of drains. Yet they sometimes do break, from the want of care in the laying or in packing the earth around or under them, especially where passing across the earth newly filled around the outside of a cellar wall. Such places should always be puddled with water when filling, both under and over the drains. Of course, every leak is a source of great risk, contaminating the soil in its vicinity to an extent dependent on its permeability. In short, no workmanship can be too good to be employed in laying house-drains. They are out of sight, and, therefore, out of mind. Moreover, a defect can only be detected after months, if not years, during which time the soil may have become polluted to an incurable extent, rendering a home a mere pest-house which might otherwise have been healthy.

Good workmanship is essential.

The increased use of water in our houses is justly regarded as one of the most valuable agents in raising the standard of cleanliness among the poor, and in contributing to the comfort and luxury of the more wealthy. But it must not be forgotten that it brings with it these increased risks, and demands the most careful attention; for the more water we dilute our sewage with, the further will it penetrate through pores and diffuse itself through the soil, unless securely led off in proper channels to proper places.

Increased use of water brings greater risks.

Drains Within the House Walls.

The above remarks apply chiefly to the drains outside of houses. But that portion of the drain which is *within* the walls deserves still more rigid scrutiny. The soil outside has certain absorbent powers, combining chemically with the poisonous gases, or holding air in its pores for their partial oxidation. Moreover, the poisonous influences within the walls, are much more likely to be absorbed by and act upon our systems through the lungs, than those which are partially shut out by the walls, or partially diluted by the open air. A New England climate does not admit of much "fresh air"

Drains inside the house.

The poor cannot afford fresh air in winter.

inside the homes of those who cannot afford to heat it during six months of the year. The suffering from frost is immediate, leading the poor man to calk every crack, while bad air is a slow poison, warning us perhaps by the sense of smell, in some degree, yet not in the urgent manner which would lead to an appreciation of its importance. If not immediately attended to and changed, the bad air soon ceases to attract our attention through the sense of smell, and is never thought of as a serious matter by a large part of our population. In fact, they might perish with the frost if they failed to shut out the pure air, and so choose the chance of living by shutting out both frost and air together. We must therefore expect to find poorly ventilated houses among the poor in winter. The exhalations from the skin and lungs are, unfortunately, not so easily collected and got rid of as the fluid and solid excretions of the body. But in getting rid of the latter, if we do not take great care, they, too, become gaseous, and return to plague us in the air, already heavy with the vapors from the lungs and skin in badly ventilated houses. The introduction of water-closets and slop-sinks into tenement houses should therefore be guarded with peculiar attention, or the benefits to be derived from their use will be more than cancelled by the evils which may arise from their defective construction.

"Modern improvements" in cheap houses.

A great number of houses have been built within a few years upon speculation in the vicinity of Boston and other large towns by a class of professional builders who erect long blocks with borrowed money, reducing the cost to a minimum by doing the work in a wholesale way, building by the dozen as it were. Every part of the work is subjected to competition and the lowest bids taken, regardless of the reputation of the builder. The drainage and plumbing of such houses is generally calculated to please the eye by a display of marble slabs and plated mountings in convenient places; but there being no reward offered for good workmanship or good planning, neither is to be expected. It is here we find a combination of bad designs, defective work, and poor materials, with a display to catch the eye, making a sort of man-trap or whited sepulchre; for no sooner does a family attempt to use such a house as a home, and to turn its drainage into the

receptacles conveniently provided for the purpose, than we find sewer-gas diffused everywhere. The occupants of such a house would be safer, in many cases, if all their sewage were thrown into the middle of the street, or even on the side-walks, to decompose in the sunshine, or to be eaten by the dogs and rats in true Oriental style; for the products of its decomposition would then at least be diluted and scattered by the winds, and would not be carried about their houses in concentrated form by pipes and passages, to poison the air of the bed-chamber and nursery.

Lightne sewer-g

Menzies says (page 13): "The gas which arises in foul drains is of a singularly light character, and has a tendency to ascend or draw towards any heated part of a house. Hence it often arises that houses in towns situated on the highest ground are more unhealthy than those in the valleys,—the foul air rises to them through the drains! As during the greater part of the year the internal temperature of an inhabited dwelling, and especially of some parts of it, is much higher than the surrounding atmosphere, it is obvious that the gas naturally ascends to the living-rooms, especially if during the winter and autumn they are warm and comfortable. These water-closets are also generally on the bedroom floor, and it is more injurious to health to sleep in foul air than to be in it during the day-time."

Drains led out the wal

In planning house-drains, they should be got outside the walls of the house as directly as possible. In public institutions, or other large buildings, where a large number of receptacles of sewage is provided, the main drain for the collection of the whole should be outside the walls, wherever practicable, for the reason that fewer joints of pipe, and fewer chances of leakage from imperfect work, would thus occur within the walls.

Materi drains inside houses

Cemen pervio gas.

The material for drains within the walls should be metal in all cases. It is often customary to lead a drain across under a basement floor by stoneware pipes, which, though much better than the old-fashioned brick drain, is far inferior to iron. The writer has seen such a drain, well laid with Scotch pipe and full cement joints, and covered with concrete of hydraulic cement on the cellar floor, giving off through this cement an amount of stench that made the cellar nauseous,

even though the soil-pipe above was ventilated. The sewer in the street may have been in fault, but this case serves to show how penetrating are these gases, and that good hydraulic cement mortar, though impervious to water, is not impervious to them. A ventilated trap outside the house afterwards stopped this nuisance in the case referred to, but even this may not be enough in all cases, for a certain amount of slime inevitably collects upon the insides of house-drains themselves, which, by its decomposition, evolves gases requiring metal joints to hold them. Menzies says (p. 14), "I have known this gas pass through floors and through chinks in two-feet walls. It will find out the smallest opening in any pipe that will give it a chance of getting to the heat or the open air." This same gas, if escaping from a slight leak in a drain buried in the soil outside the house, would doubtless be absorbed and rendered innocuous by the soil and by the air within its pores, but under a house the case is widely different. Cast-iron pipes, with leaded joints, well calked, and painted, are safe; and unless subjected to such great changes of temperature as might loosen the joints by expansion and contraction of length, will prove satisfactory for a long term of years.* If iron is used inside the walls, there is seldom anything to be gained by burying it under the cellar or basement floor. Such pipes should be readily accessible for inspection. If a little attention be devoted to the subject, they can generally be placed along some wall or partition, or hung from the ceiling, where their joints can all be readily seen to be recalked and painted whenever necessary. If a water-closet be placed in the basement, it should be near the wall, where the soil-pipe leaves the house, so that this pipe, passing just above the floor, can serve for its drainage. If necessary to this end, the floor of the closet can be raised one or two steps above the rest of the basement floor. Prof.

Sewer-gas very penetrating.

Iron pipes.

Should be above floors in basements.

* Latham, in his Sanitary Engineering (p. 319), gives preference to lead over iron for soil-pipes. But the superiority of cast-iron over lead has been amply proven in this country for over ten years. Latham's objection to the rusting of iron pipes may be applicable to wrought-iron, but does not seem valid as to cast pipes, the insides of which soon become coated with a film, beyond which the rust does not penetrate far. Lead soil-pipes, on the other hand, are very difficult to secure against sagging out of place, against rats, and against corrosion, or nails carelessly driven.

Parkes says (Practical Hygiene, p. 343): "It should be a strict rule, that no drain-pipe of any kind should pass under a house. If there must be a pipe passing from front to back, or the reverse, it is much better to take it above the basement floor than underneath, and to have it exposed throughout its course."

It has been a common practice in England to provide a drain from the cellar or basement into which the scouring water can be emptied which is used in the washing of floors, etc. This drain is generally discharged into the main drain outside of the house. A trap is generally provided under the gulley or sink where the water is poured, but, as the place is not in daily use, this trap is likely to become dry or filled with sand from the scouring water, and in either case useless. It is better to dispense with the trap in such places, and depend upon the trap which should always exist outside the house. The only risk of bad gas from such a sink, would be from the other house-drains themselves. This risk is not to be ignored, and in order to escape it, such a sink should be placed, not under the house, but in an outer shed, or, better yet, in the yard, outside the house, where a grating can cover it. A pocket or catch-basin for sand should always be provided under the grating. Cellar and basement drains.

The drainage of the soil on which a house is built, if it consist of porous sand or gravel, will not require much attention, unless the level of the cellar be decidedly below that of most of the surrounding land, as in broad plains or valley-bottoms. When such cases occur, or when the soil is impervious, a porous tile-drain should be laid, three or four feet deep if practicable, with porous material over it around the bottom of the foundation-wall, with a delivery to the house-drain above its outside trap which disconnects it from the sewer. In case no sewers are provided, among a scattered population, such a drain can generally be led to some point low enough to discharge it on the surface of the same lot; if not, the lot is very ineligible for building purposes. Foundation and subsoil drains.

Branch drains from sinks, wash-trays and wash-bowls are generally made of lead, which seems to be the most suitable material. Its pliability and durability are valuable qualities. The first may lead to its distortion of form, by sagging, if not Branch waste-pipes.

well supported. Where these lead waste-pipes enter the iron ones, a common practice among plumbers is to secure the joint by glazier's putty. This is but little better than a rag packing for such a place, for the slightest expansion and contraction of the pipes, endwise, by changes of temperature, will crack the putty and lead to its crumbling away in one year. The only proper way to make such a joint, is to solder a tinned iron or brass ferule to the outside of the lead pipe, which is to enter the bell of the iron pipe. This ferule gives a stiff material against which a lead joint can be calked in the same way as between two pieces of iron pipe. This lead packing will yield to the expansion, without breaking or crumbling. When lead traps are used under water-closets, the joint between them and the iron soil-pipe should be secured in the same way.

Putty joints.

Delivery of waste-pipes from bowls, etc.

The connection of waste-pipes from wash-bowls, bath-tubs, wash-trays, and of tank overflows, with the soil-pipes, has given rise to much trouble. In this neighborhood, it is customary for plumbers to enter them into the trap of the nearest water-closet below the water-line. This is often carelessly done, making the connection so near the surface of the water in the trap that the seal is not reliable. Moreover, the emanations of foul gas from the water in the trap would rise through the cistern overflows and render the water in such cisterns unsafe for drinking, for the rarity of the use of such overflows renders traps in them liable to dry up, and therefore of little value. The English discharge such waste-pipes over a grating in the open air, which drains into the main drain below, thus insuring complete disconnection. But this is not practicable in our climate, and we must seek some other method. The overflows of tanks must needs have open mouths at their upper ends, and should, therefore, not connect with a foul pipe below. The rain-water conductor from the roof is a fit place to discharge them, unless itself connected with the drains below. When thus disqualified, the overflows can terminate in the open air outside the house, for they will never carry water enough to cause annoyance, the water being always clean. The wastes can be safely discharged, as above described, into a water-closet or slop-sink trap, if pains be taken to enter them at its bottom, as far as possible below the

Overflows.

English method impracticable here.

water-line. If such wastes are of considerable length, say ten feet or more, they may become offensive, from the decomposition of the slime inside them in warm weather, and should have S-traps near their upper ends, with vents from the top of these traps at least one inch in diameter, connecting with the main vent of the soil-pipe. The practice of drawing drinking-water from a tank or cistern must be condemned under any circumstances. There is no reason for it, with a constant supply in the mains, such as is universally given in our country. The practice originated with the system of intermittent supply, formerly prevalent in England, but now going into disuse.

Drinking-water should not be drawn from tanks.

Soil-pipes from water-closets were formerly made of lead, at first by soldering sheet-lead into cylinder form, and afterwards by the seamless process. The first show more rapid corrosion at the solder-joint; both are subject to corrosion and sagging, and to being gnawed by rats. Iron is much safer, and fortunately cheaper also, and is therefore now generally used.

Material for soil-pipes.

Plumbers sometimes connect branching soil-pipes by T-joints, when it serves their convenience. Y-joints should always be used, for the same reasons as given above for connecting outside drains. The Y-joint sometimes requires the introduction of another small bend to complete the necessary change of direction. Hence arises the temptation to use the T-joints in contract-work, to save the cost of the bend and its application.

Y-joints, and no T's.

Rain-water cisterns are sometimes built in basements, or outside of houses, underground, having their overflows in the house-drain. Such an arrangement is never safe. However carefully the overflow may be trapped, the long drouths of our climate may dry up the water-seal, and allow the sewer-gas to spread over the water and be dissolved by it. Moreover, the drain may be obstructed below the junction of the overflow, and the whole house-sewage is then backed up through the overflow into the cistern. Such an instance actually occurred within the knowledge of the writer, where about a barrel of grease was allowed to collect in the drain from the kitchen-sink, after filling the cesspool provided for the purpose. The first intimation received of this obstruction by the

Rain-water cistern overflows.

occupants of the house was that the cistern-water, which was used through a filtering-pump for drinking, got a "coppery taste," as they expressed it. On cleaning the cistern, it was found that the whole drainage of the house had been emptying into it, apparently for some weeks. Cistern-overflows can generally be discharged on to the surface.

Receptacles for grease.

The need of pots, tanks or other receptacles for the collection of kitchen-sink grease, has been alluded to above, and will be generally felt in all houses where the inclination of the drain is not very rapid. The writer has tried various devices for this purpose. The subject is ever fruitful of annoyance, especially among small families who employ no man-servant, and whose members dislike to meddle with dirty messes. Sufficient space must be given for the accumulation of grease during the intervals between the times of cleaning. The inconvenience of frequent cleaning in our winters, when the congelation of the grease is most rapid, and the inconvenient depth below the surface required to escape frost, have led to putting them in cellars, and even above the kitchen floor, under the sink, in some cases. The latter was found unendurable, from the stench arising when cleaned, and the frequent cleaning rendered necessary by the limited space for storage. Stoneware pots were tried, of about ten gallons capacity, both in kitchen and cellar. When in the cellar, the cleaning is less offensive; but in severe weather it is difficult to so ventilate a cellar as to keep out of the house all effluvia so arising, while their limited size requires attention once or twice every month in winter. In the days when our grandmothers presided over their houses, there was more attention given to the small economies of the household, either by those grandmothers in person, or by some servants who felt more impressed with the sin of wastefulness than do the denizens of our modern kitchens. Certainly there is a value in the grease now thrown away in dish-water which ought to lead to its being collected before going into the water, instead of encumbering our house-drains with it to such an extent as is now done. Until such an end be attained, however, some means must be provided for keeping it out of the pipes, for no matter how large these may be, if as large as a flour barrel, they would be filled solid with grease in one winter by

some sinks, even where the family consisted of but five persons, all told. The best plan yet devised for this purpose is, perhaps, a small brick tank, laid in hydraulic

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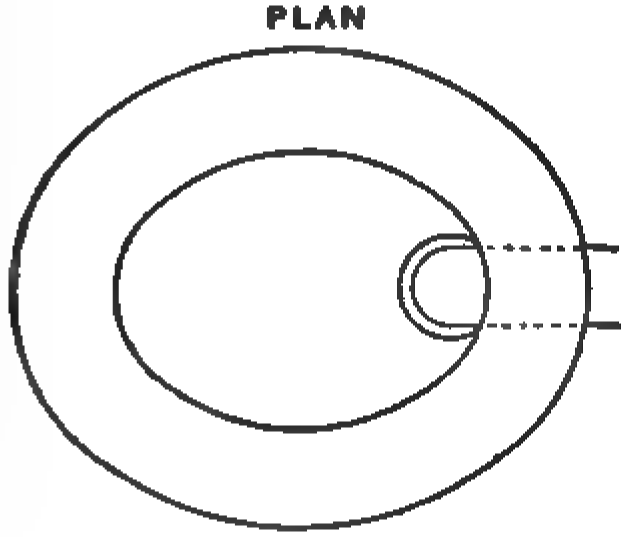
FIG. 5.—Cesspool or tank for grease.

the same wall on the inside, so that the grease shall not congeal in the pipe between the two. (See Fig. 5.) For small and medium houses it should be from one and a half to two feet square on the inside, with the bottom about two feet below the outlet-pipe, which is to turn down about a foot on the inside, with a smooth, round turn, so that its mouth may be so much under water. The inlet should be about six inches higher



than the outlet-pipe, to allow the grease to collect to that

thickness above the water line, which is governed by the level of the outlet, without obstructing the mouth of the inlet. The grease will then float on the water, and become congealed in the form of a dirty scum, while the water and other matter in suspension flow out by the mouth of the outlet, about a foot below the surface. The whole must be so placed as not to freeze. The depth needed for this will depend largely upon the exposure. The walls being built to the surface of the ground can be covered with a flag-stone, with hole and iron cover.

The soil-pipes from the water-closets should by no means enter this receptacle. It should be upon a branch drain, serving the kitchen and scullery sinks alone, having its outlet into the principal drain.* If more than one sink delivers into it, the tank itself should have a vent-pipe, to prevent the air, compressed by the influx of water from one sink, from being forced up through the trap of the other inlet-pipe into the house. If the waste-pipe becomes choked with grease between the sink and cesspool, as will often happen when the fall is not rapid, it may be sometimes kept clear by flushing occasionally with boiling water, provided the passage be not wholly obstructed.

Fixtures inside the house. Waste-pipes found in too many places.

The demand for modern conveniences has introduced waste-pipes all over our houses. Their orifices are found in bedrooms, and on every floor, from attic to cellar. With perfection in planning, workmanship and management, such things may possibly be made safe. But we cannot expect perfection in either of these departments. The nearest approach to it ought to be looked for among the homes of the wealthy, whose means can command the services of good architects and good workmen, and who are not stinted as to the cost of

* The reason for excluding the soil-pipes of water-closets from the grease-pot or tank,—though their introduction is apparently recommended by Col. Waring, in speaking of Field's flushing-tank,—is the same as has been given against the storage of all fecal matter near a house, for however limited a period, in hot weather. Moreover, the separation of the grease is much more difficult if fecal matter be introduced into the same receptacle. Field's flushing-tank is doubtless an excellent arrangement for mild climates; but our winters would require its inlet to be placed so far below the surface, that the additional depth required to work the siphon would render its outlet inconveniently deep, except where the ground slopes rapidly, and then the flushing is of little importance, comparatively.

such appliances as conduce to safety in drainage. But it is precisely in the most costly houses that the waste-pipes are found most widely scattered. The chances of imperfect work are too great to justify the practice of putting wash-basins or water-closets in sleeping-rooms under any circumstances, or even in dressing-rooms, closets or passages leading directly from sleeping rooms, unless these conveniences are supplied with the most ample and thorough ventilation, put together in the most careful manner, and most scrupulously taken care of. English authorities say that water-closets should be built over one another in a tower projecting from the house.* The placing of one over the other is a great advantage in point of economy of construction. But the placing them outside of the line of the house-walls is hardly practicable in our climate. Our winters compel their construction, either on the southerly side of our houses or in their interior, unless special heating arrangements are applied. It therefore becomes all the more necessary to provide special means for their ventilation.

Waste-pipes not to be in sleeping-rooms.

Placing of water-closets.

The water-closet is used by thousands who know little or nothing of its mechanism, and who necessarily consider it as an automatic arrangement, needing little or no attention, and who therefore bestow none upon it. But, as it is no more perfect in its way than all other work of human hands, it has many faults and weak points, particularly in the form of the pan-closet, now so generally used. It therefore behooves the architect who plans a house for the rich man, the mechanic

General ignorance as to their mechanism.

* See Eassie's "Sanitary Arrangements," page 62; also the supplementary report for 1874 of the medical officer of the Privy Council (England), from which the following extract is taken, page 33:—

"In considering the admissibility of water-closets, it has always to be remembered that the working of an ordinary water-closet is easily deranged, and that water-closets, when out of order, and especially if in the interior of houses, are apt to become very dangerous nuisances. The ordinary water-closet is, therefore, a thoroughly ineligible form of privy for those who are unlikely to take proper care of it, or are from poverty unable to give it such occasional repairs as it may require."

"Among such classes of population it is, of course, unfit that any form of indoor privy should ever be sanctioned; but even in the best-ordered houses the occasional danger of indoor water-closets must not be disregarded. Water-closets ought never to stand where they cannot have outside windows: they ought, if possible, to stand as projections from the body of the house, and with windowed lobbies dividing them from it."

who plans his own, or who builds to sell again, and lastly the householder and head of family himself, to know something of the general principles of its construction, and to avail himself of such knowledge in planning, building and taking care of a house. There seems to be a deplorable lack in this respect, for instead of closets and drains, placed so as to insure the getting rid of the refuse with safety, we often find poisonous gases emitted from them, and conducted all over the house, by an ingenious system of pipes, floor-spaces and partition-spaces in our plastered buildings.

Water-closets of ancient origin.

The use of water-closets dates from a very remote period. Thomas Ewbank, in his historical treatise, says (p. 561): "They are an ancient and probably an Asiatic device. The summer chamber of Eglon, king of Moab (Judges iii.: 20–25), is supposed to have been one. They were introduced into Rome during the Republic. Those constructed in the palace of the Cæsars were adorned with marbles, arabesques and mosaics. At the back of one still extant, there is a cistern, the water of which is distributed by cocks to different seats." Their general use in private houses dates, however, from a very recent period. It is to be regretted that among the hundreds of patented inventions, recently brought before the public, one of the most defective and dangerous of them all should have got into such general use in this country; viz., the ordinary "pan-closet." Baldwin Latham speaks of them in his "Sanitary Engineering" (page 329), as "cumbrous appliances, which cannot be introduced into a house without creating a nuisance." The fact remains, however, that thousands of our fellow-citizens have already fitted their dwellings with them, at a considerable cost, and it becomes important to remedy their defects as far as possible where already in use. The following devices are recommended for those who have already made this bad investment, while advising those who are building anew to adopt some of the simpler and safer inventions which will be described afterwards.

Ordinary style very defective.

The pan-closet is described in the annexed cut, figure 6, and consists of several parts: *First*, The bowl of crockery, directly under the seat. *Second*, The copper pan, which, when ready for use, is in the position shown by the dotted lines, is full of water, and seals the bottom of the bowl.

Third, The cast-iron receiver, standing on the floor, within which the pan is tilted when discharging its contents; and *Fourth*, The lead trap just below the floor. Its defects are numerous, but its chief defect arises from the reservoir of foul air always present in the iron receiver below the crockery bowl. The inside of this receiver is necessarily foul. It is quickly smeared with filth when first put in use; its in-

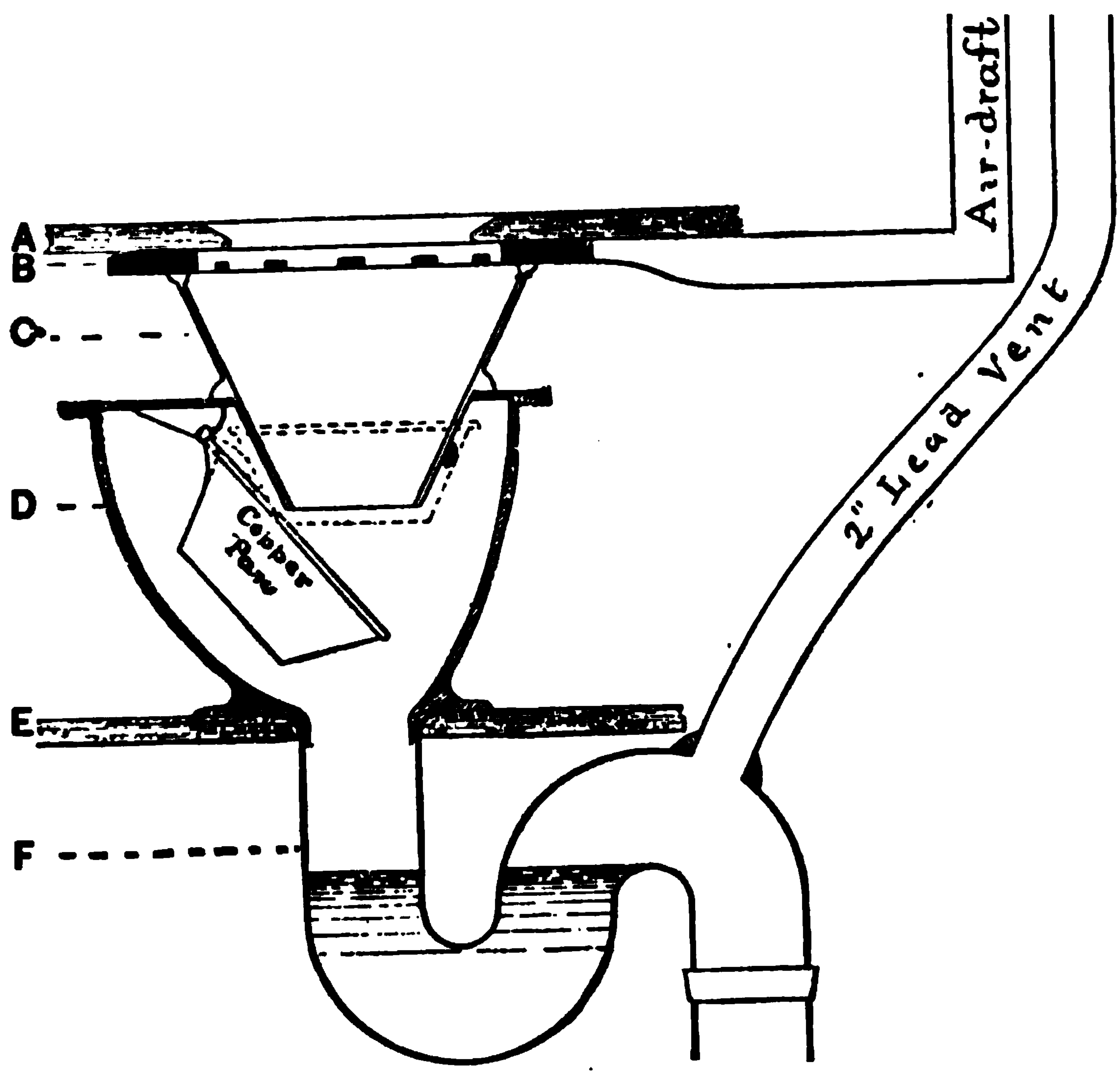


FIG. 6.—A, Wood seat. B, Annular ventilating tube. C, Crockery bowl. D, Iron receiver. E, Floor. F, Lead trap.

terior is inaccessible, and can therefore never be cleansed. Directly below it is the large metal trap, whose contents generally emit noxious gas from their decomposition, and this trap cannot be safely dispensed with. Whenever the pan is tilted and discharged, there is suddenly dropped into this receiver several quarts, and sometimes a pailful of water. This must of course displace its own volume of the foul air pent up there, for which there is no escape in any direction but upward, with a rush, past the tilted pan into the bowl, where it mixes freely with the air of the room. Various

schemes have been devised for getting rid of this nuisance. When not gotten rid of, the pan-closet is a dangerous neighbor. Several devices are described by Eassie ("Sanitary Arrangements," p. 74) for injecting a disinfecting fluid by an automatic apparatus into the pan or bowl at the instant of opening the valve. Such contrivances may serve a good purpose, if well regulated, but the adjustment of these additional parts, and the occasional renewal of the disinfecting agent, complicates matters somewhat, and renders such a remedy less simple and less adapted to general use than it is desirable that it should be.

Disinfecting water-closets.

Ventilating water-closets.

If the water-closet can be located near a chimney, which is sure to be in constant use, as the kitchen chimney, the evil can be abated by building a zinc tube of some three inches diameter into the chimney-stack, alongside the hot flue, or inserting an iron tube within the old flue, and leading its

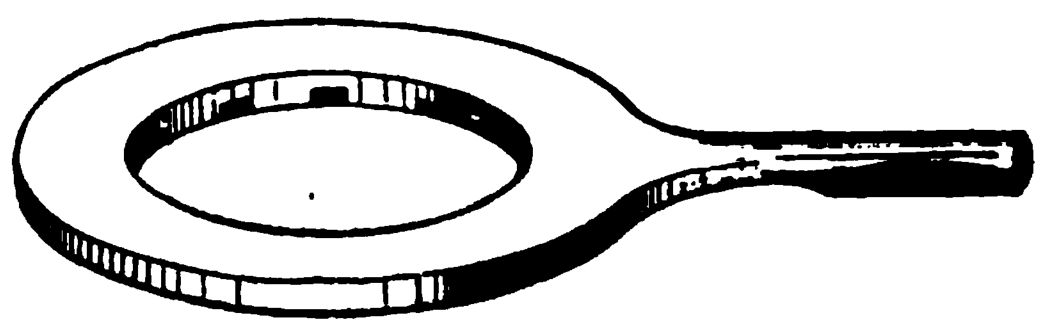


FIG. 7.—Annular ventilating-tube over bowl.

lower end into the space under the water-closet seat. In wooden houses and other houses also, if in the country in isolated positions, windy weather often crowds air up through openings in the floor from the communicating floor-spaces, so that in order to insure that the draught of this tube may draw directly from the bowl of the water-closet under such circumstances, the tube should end in an annular flat tube of galvanized iron, to be placed directly over the top edge of the bowl, and under the seat, with perforations around the inner edge of the ring, for withdrawing the air which we wish to get rid of. These annular tubes are now made in Charlestown, and are sold and applied by most plumbers. (See figure 7.) The cover of the seat must then be arranged so that the valve can be drawn after closing such cover, and care should always be taken to so close the cover before lifting the valve. The foul air which is puffed upwards at the instant of emptying the pan is then sucked up by the draught of the chimney, without

an opportunity of mixing with the air of the room. Where no warm chimney can be had near enough to be thus used, the draught-tube can be run directly through the roof, with some ventilating attachment at its top to encourage the upward draught of air. This will often work well in winter, when the air of the house is artificially heated, and tends to escape by its own buoyancy. But in warm weather, it is not so likely to be of use. At that time the chief reliance is upon open windows and a free current of air through the house. For this purpose it is always advisable to provide at least a part of a window directly over every water-closet. The pan and hopper closets which are often found tucked into corners, under stairways, and in other dark places, without special ventilation into chimneys, are sure to become nuisances, and poison all their surroundings. It has been suggested that the iron receiver of the pan-closet should have a vent-tube between the pan and the lower trap, so as to provide for the exit of the foul air displaced by the descending charge of water. But this displacement is so sudden, and in such a large volume, compared with the capacity of such tube to receive it, that this does not appear feasible. Moreover, if the inner surface of the receiver is tapped by any sort of tube, its orifice would soon be likely to become smeared and stopped by the wet paper and fecal matter which is dashed about.

Windows needed in summer.

Ventilation for iron receivers not efficient.

If an upward air-draught can be secured from the bowl, it is constantly at work, removing not only the foul air discharged when the pan is tipped, but all exhalations from water standing in the pan. This water is always exposed to the foul air of the receiver, around the outside of the bowl, and dissolves a certain amount of the gases from this source, to be given off and scattered by rapid diffusion in the air above, even when at rest, for the air is as a vacuum to other gaseous bodies. No vent from the iron receiver could remedy this, for that is foul past redemption. No circulation provided by such a vent could much affect the degree of its foulness.

Gases escape through water by solution and diffusion.

The above-described defects in the pan-closet may in some degree be remedied by an efficient air-draught, in cases where this closet is already in use, but a surer remedy yet is found

Improved water-closet.

in another style of closet, which can be applied with little extra cost when building anew. The closet made by George Jennings of London (see figure in margin) has accomplished the much-desired end of dispensing with the pan entirely, together with the air space between the bowl and the lower trap. It also dispenses with a separate trap below, having such a trap in itself, made in connection with the bowl, all in one piece of crockery. Baldwin Latham calls it "a perfect sanitary appliance." Its water-supply is taken directly from any supply-pipe, adjustable to the actual pressure, so that no separate tank, or service box or valve, wires or cranks are needed. The ordinary pan-closet alone costs less than half as much as Jennings', but its cost, with all those accessories, set up in working order, would be nearly as great. A supply direct from the pipes in the ordinary pan-closet is objected to with reason from the risk of back-flow of foul air from the closet into the pipes in case of lack of water-pressure from any cause at the moment of using the closet. But in the Jennings closet this risk is entirely avoided by the construction of the valve, which is a flap-valve, made of a rubber disc, rendering all back-flow impossible, and opening only with the pressure of water. Ample flushing of the bowl is secured by having the valve worked by a float, so that it remains open till the water reaches the prescribed level in the bowl. The Jennings closet does not seem to be quite all that could be desired, but it is certainly the best thing in the market. Its weak points are,—

Jennings Water-Closet.

First. The hollow plug, made hollow to act as an overflow for possible surplus of water delivered, allows the free escape of noxious gas, if any such there be, from the contents of the trap below. The only protection against this, as the apparatus is now constructed, would be the second lifting of the handle

every time the closet is used to insure the complete expulsion of the foul matter from the lower trap.*

Second. Most of these closets in our market have no provision for a vent-hole in the trap. The necessity for such a vent was pointed out by Mr. Rogers Field, C. E.,† and a vent-hole is now provided, when demanded, by the makers at the point marked V on the diagram.

The cut should show the plug to be hollow, to act as an overflow. The draughtsman drew the plug in elevation, while he should have drawn it in section.

With this closet, the use of a disinfecting fluid, or the special ventilation of the closet-seat will probably be needless. But it does not escape the need of giving a vent to its own trap, as above described.

Vents for soil-pipes.

A copious vent for the soil-pipe itself should never be omitted.‡

The reason for this vent is as follows:—

The main drain of the house is supposed to be provided with a large trap, outside the house, as described above. There is also to be a trap under the water-closet, or forming a part of it. Between these two traps there must always be a confined column of foul air; this column, if not connected with the outer air by a vent made for the purpose, is subject to compression or tension from the following causes, acting together or separately. Compression is caused,—

Why always needed.

* Since the above was written, the writer learns that this defect has been entirely remedied by Mr. Jennings. He now attaches an inverted cup to the handle, just above the hollow plug, which effectually traps this air-hole. Parties ordering Jennings closets, should see to it that this important improvement is not omitted.

† The following is taken from a private letter of Mr. Field to the Secretary of the State Board of Health, in speaking of such a vent-pipe: "The function it has to perform is simply that of admitting air whenever the closet is worked so as to prevent the water being sucked out of the trap by the partial vacuum that would otherwise be created by the sudden rush of water down the arm leading from the closet to the soil-pipe. This pipe in no way does away with the necessity of having the soil-pipe properly ventilated; and, *vice versa*, the ventilation of the soil-pipe by carrying it up above the roof does not do away with the necessity of this air-pipe."

‡ Mr. Simon, in the report above quoted, says: "That every private drain having inlets within a house, must have ascending from its head or heads into some suitable high position in the open air, and where it cannot infect the interior, a ventilating pipe or ventilating pipes of sectional area amply proportionate to its own."

First. From changes of temperature, either from change in that of the surrounding air, or by the pouring of hot water into the pipe.

Second. From the blowing of air into the soil-pipe from the sewers, which may not always be ventilated, and which may occasionally find the disconnecting trap disabled from some accident.

Third. From the influx of a considerable volume of water into the column from above, forcibly displacing an equivalent volume of air.

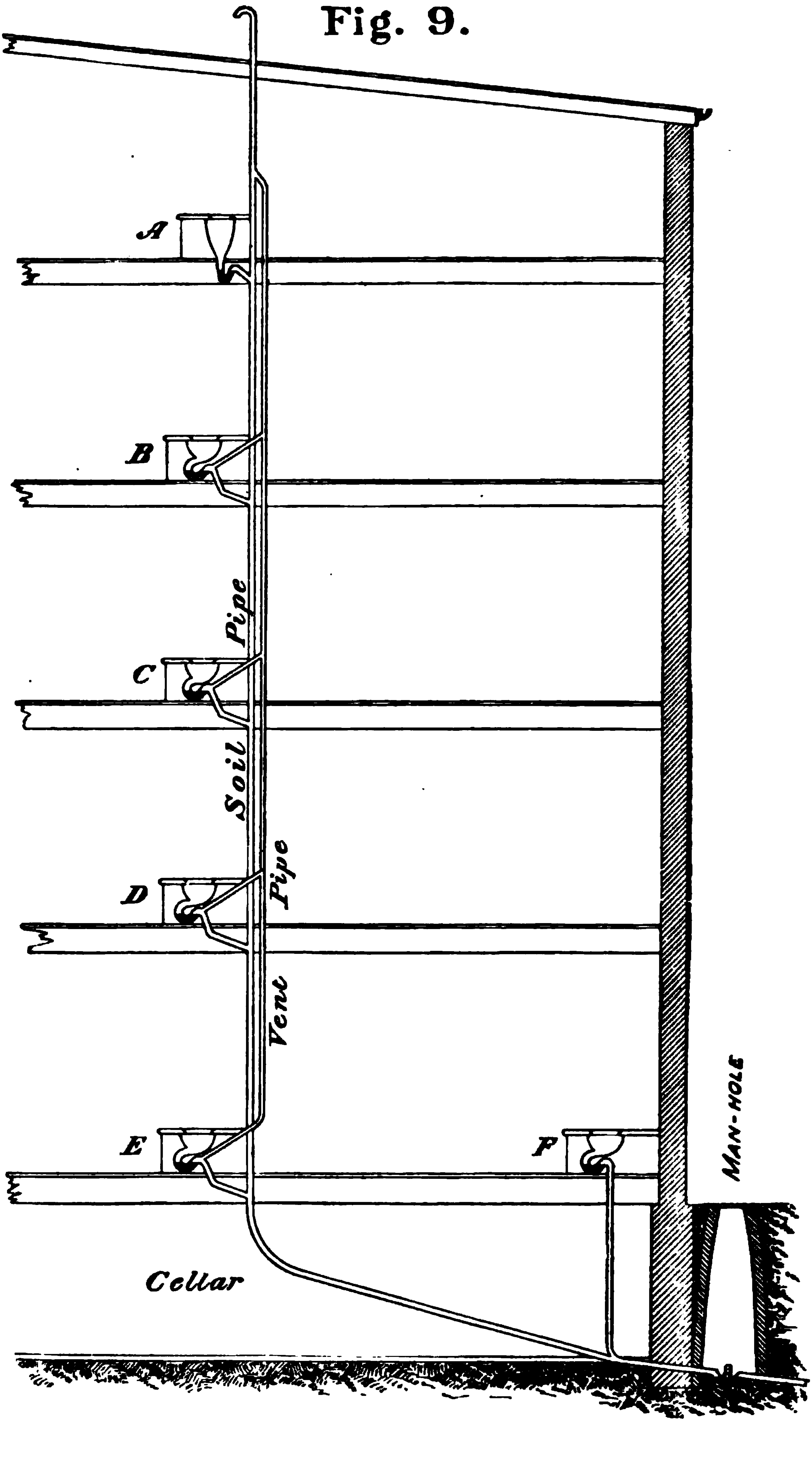
When compressed from either of the above causes, the foul air is blown out into the house at the orifice of some waste-pipe in connection, in spite of its trap.

Soil-pipe to be carried up through roof.

Tension may occur from the reduction of temperature, or from the efflux of water as it leaves the confined column through the outside trap. In either case the vacuum is supplied by sucking the water out of some of the connecting traps, leaving their waste-pipes unsealed. The remedy is simple enough, and is often applied now in new buildings by carrying the soil-pipe up through the roof, with an open end, to connect the interior with the open air. In small houses, having but one or two water-closets, it will answer the purpose to apply a two-inch lead or iron pipe, to run from the top of the trap of the upper closet, up through the roof. If, however, the outside disconnecting trap is not ventilated, as above recommended, and if such small houses empty their drain into a public sewer, *nothing less than the whole size of the soil-pipe will be safe for its vent.* In building new houses, it is recommended that the soil-pipe be carried beyond the roof, and of its full size. If the sewers are ever tide-locked, a heavy rain at such times displaces an immense volume of air, which is forced into the house-drains, causing these vents to be fully taxed.

Where several water-closets are placed one above another, on different stories, drained by a perpendicular soil-pipe, as often occurs, it is not enough to extend the soil-pipe up through the roof. The trap on each of the closets below the upper one, except perhaps the very lowest, if this be at the bottom of the column, must have its own separate vent, otherwise the rush of water down the column from the upper

Fig. 9.



story, or from any of the closets above the lower one, will be likely to siphon the water out of the intermediate traps in passing, or the trap itself which is used. The vents for this purpose should be at least two inches in diameter, and may all branch into each other and into the soil-pipe above the upper closet, as shown in the annexed diagram, Fig. 9. Thus, if we suppose a pailful of water to be emptied into the slop-sink on the upper floor at A, its rapid fall through the vertical soil-pipe would be likely to take with it by friction the air in the branches draining the closets at B, C, D and E. The traps of these closets would be likely to be drained by this siphon action, as above described, or by their own use, unless provided with vent-pipes, as shown in the figure. A closet placed as at F, connecting with the main soil-pipe where the latter is not vertical, is not subject to such action from use of those above, and has been found by actual experiment to be unaffected by their use when the main soil-pipe has an open top, as here shown. It would therefore probably not be necessary to apply a special vent-tube to its trap unless the vertical pipe immediately below it is several feet in length. If such be the case, the discharge of this closet itself might siphon the water out of the trap behind it, unless such a vent be provided, so that it is hardly safe to omit the vent in any case.

Simpler water-closets.

For those places where the cost of a Jennings water-closet is felt to be a burden, a simple hopper-closet is the best substitute. But it should be properly ventilated under the seat, and its trap ventilated, and good provision made for flushing. This closet is described in Fig. 8 (p. 454), and consists of a hopper or bowl of crockery, set over a lead trap, or, what is better, a bowl with crockery trap in one piece. This closet gets rid of the confined chamber of foul air which condemns the pan-closet, and this is also easily cleaned, and simple. Its only fault is that the contents of the trap are directly exposed, so that trouble would ensue if ample flushing were not provided. It is sometimes provided with a constant flow of a driblet of water, which is both wasteful and inefficient. The flushing-water is needed only at the time of using the closet, or rather when leaving it, and it should then be applied in a sufficient quantity to drive the contents of the

trap entirely through into the drain below. If a tank or service-box be applied to flush it, a definite supply of water can always be insured without such a waste as would render its use objectionable. In the way it is now used, the large amount of water wasted has led to the imposition of a special tax upon hopper-closets by the Boston Water Board. This waste, however, is an abuse, and not a necessary contingent upon the hopper-closet. The aperture at the bottom should be limited to about three inches in diameter, to prevent the admission of substances which might choke the drain.*

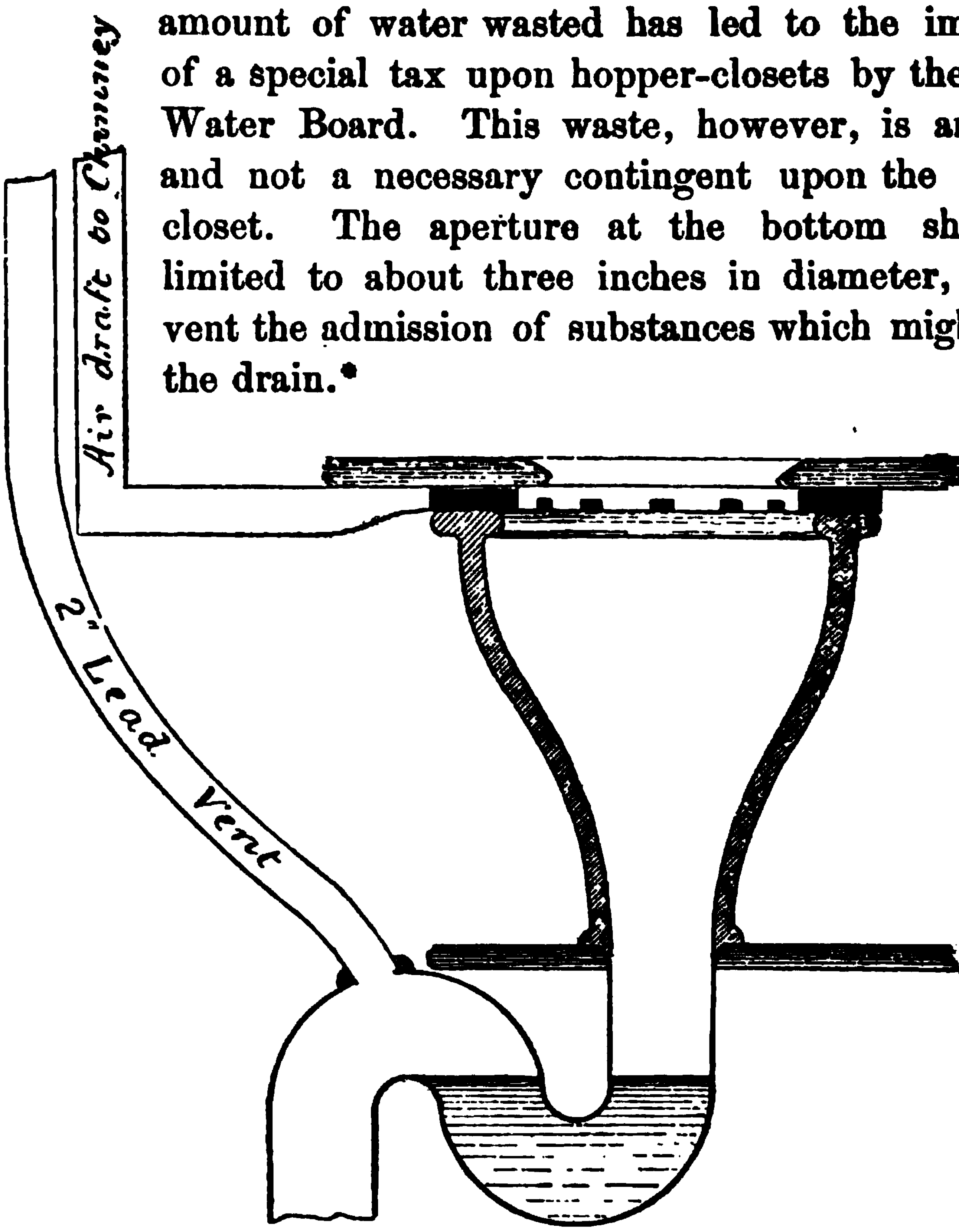


FIG. 8.—Hopper-Closet.

Direct supply of water-closets.

It has been usual with many plumbers of late to recommend the flushing of water-closets of the common "pan" or "hopper" style by a valve to be opened in a branch of

* In order to insure a sudden delivery of water to expel the foul contents from the trap of a hopper-closet, the service-box should have a capacity of at least a gallon, with a funnel-shaped bottom. The valve should be not less than two inches or two and a half inches in diameter, and the pipe leading the flushing-water to the hopper should be two to two and a half inches diameter, according to its length. Without such special provision for the sudden dash of water in a considerable volume, the exposure of foul matter in the trap would be sure to give trouble, as is the fact in all those in common use.

the main water-supply of the house, from which drinking-water is drawn through another faucet. But the only safe way is to break this connection by providing a small tank and service-box for the closet. With the valve furnishing water direct from the main, the following risk is incurred: The water-supply, even though nominally "constant," is sometimes shut off temporarily for repairs in the street, and if at such time the water-closet valve should be opened, the air is drawn rapidly into the water-pipes from the interior of the closet, which is filled with organic vapors, and perhaps with actual contagium from disease. The water is soon let into the pipes again, mixing with this air and dissolving a portion, thereby becoming contaminated and unfit for drinking. This direct connection-valve has become so popular that one of the prominent dealers in plumbers' supplies recently alluded to the service-box supply as an "old-fashioned way which was going out of use," while conversing with the writer. In the supplementary report of the medical officer of the Privy Council for 1874, there is an interesting report from Dr. Buchanan, upon an outbreak of enteric fever in Caius College, Cambridge, where fifteen students were attacked while living in a building which was supposed to be provided with the most perfectly arranged sanitary appliances. After a most painstaking investigation, the fever was traced, by convincing evidence, to the use of a water-closet with direct supply from the mains, which had poisoned the water used for drinking in precisely the manner indicated above. In the same report, the following extract is found from the regulations under the metropolis water act of 1871: "These regulations having for their object the preventing of undue consumption or contamination of water, are the result of an inquiry made for the Board of Trade by Lord Methuen, Captain Tyler, and Mr. Rawlinson, C. B. They have the sanction of the Board of Trade, and may be put in force by the London water companies." "Every boiler, urinal and water-closet in which water supplied by the company is used (other than water-closets in which hand-flushing is employed) *shall*, within three months after these regulations come into operation, *be served only through a cistern or service-box*, and without a stool-cock, *and there shall be no*

Fever at Caius College, Cambridge.

London regulations for indirect supply to water-closets.

direct communication from the pipes of the company *to any boiler*, urinal or water-closet." "No pipe by which water is supplied by the company to any water-closet shall communicate with any part of such water-closet, or with any apparatus connected therewith, except the service-cistern thereof."

PUBLIC PRIVIES.

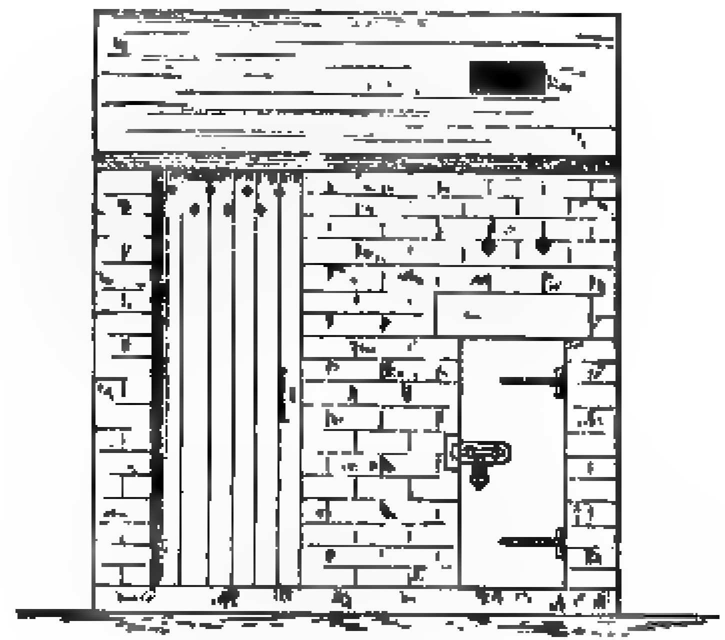
Public privies needed.

The need of a system of public privies for the crowded parts of large towns is a subject inviting the earnest attention of all who are interested in sanitary reform. All decent people who have occasion to frequent the narrow and crowded alleys where the poorer part of the people are lodged, will often be reminded of the streets of Rome and other European cities by the want of decency there prevailing. Among the various appliances used in different towns for this purpose, all have failed, unless where kept under the supervision of the local authorities. One thing is certain: the removal of filth is imperative, and it cannot be left for the people who use such public privies to take care of the apparatus. Under the same class may be considered the privies of jails, asylums, and other public institutions where large numbers are housed whose habits of cleanliness cannot be relied upon. For this purpose the water-carriage system is quite as applicable as in private houses, if only suitable apparatus be provided, and if it be supervised by local authorities. Such apparatus has already been perfected in Liverpool, and in Bristol, England. Similar apparatus has lately been introduced in the schools at Dantzig, where the climate is about as rigorous as in Massachusetts. Annexed to the report of the medical officer of the Privy Council for 1874 is an interesting report by Mr. J. Netten Radcliffe on the means used in various towns for removal of excrement. Among his "conclusions" is the following (p. 154): "As regards the parts of a town or village inhabited by the poorer classes, a water-closet system may be managed so as to be entirely applicable to the circumstances of the most ignorant and most careless population. Essential conditions of such applicability, however, are, that the structural arrangements should be adapted to their purpose, and that the management should be wholly undertaken and efficiently done by the servants of the sanitary authority.

Liverpool trough-closets.

LIVERPOOL CORPORATION. TROUGH WATER CLOSET.

FIG. 10.



ELEVATION

SECTION THRO' A.B.

A

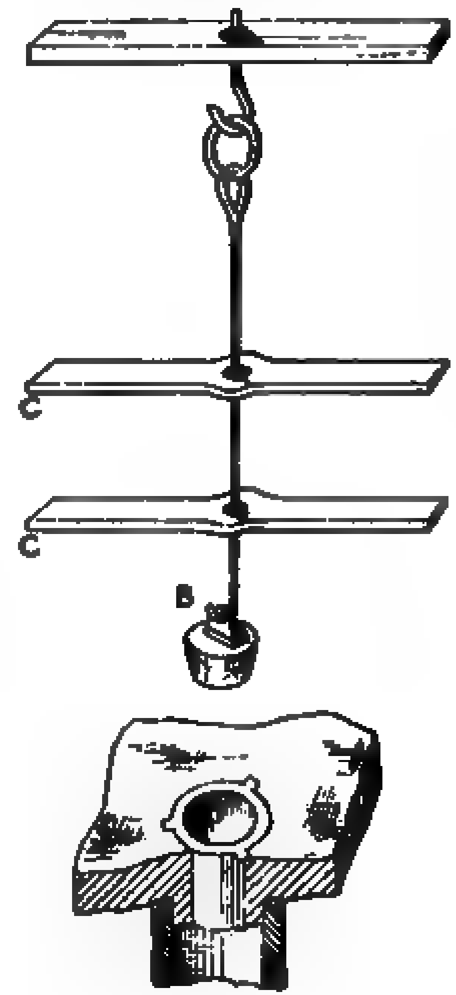
PLAN

Scale of Feet.

A. Water Supply from Hydrant with Hose inside Chamber.

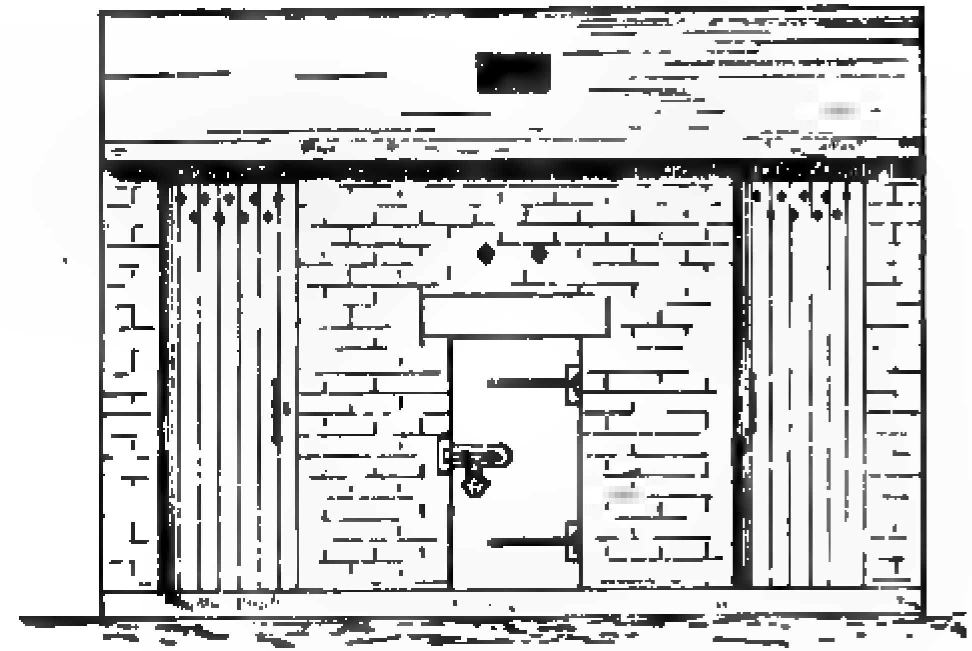
LIVERPOOL CORPORATION. DOUBLE TROUGH WATER CLOSET.

FIG. 11.



SECTION THRO' A.B.

A



ELEVATION

B

B. *Enlarged Drawing of Valve, Guide rods* (C) *&c.*

D. *Water supply with Hose from Hydrant fixed in Court.*

Scale of Feet.

0 1 2 3 4 5 10 ft

Where these conditions are observed as thoroughly as they are observed in parts of Liverpool and Bristol, water-closets are the best means of removing excremental matters from the poor neighborhoods of a town." In speaking of the introduction of these improvements in Liverpool, the same report says (p. 206): "The council, in order to secure uniformity of action, and likewise to prevent future mistakes in the application of remedial measures, directed the town clerk to notify the several owners against whom proceedings should be taken, 'that it appears to the said council of the said borough, that the only effectual remedy for such privies and cesspools is by converting the same into water-closets.'"

"Since Dr. French has been medical officer, and mostly since 1866, he has ordered and obtained the conversion of 14,393 privies into water-closets; and there were in 1869, in Liverpool, 20,000 privies attached to ash-pits and 31,150 water-closets, 2,150 of which are tank or trough closets." "These closets are constructed on a pattern ordered by the corporation, and approved, as to details, by the borough surveyor. Now, in 1874, the number of troughs for trough-closets is 3,304, serving for about 6,000 closets, and the number of water-closets other than trough-closets, 43,395." In order to explain more definitely the nature of the trough-closet, the annexed plates are copied from the same report of Mr. Radcliffe (figs. 10 and 11), with the following remarks (p. 206), viz.: "There is peculiar interest in the arrangement and working of the trough-closets which are in use by numerous families in the sort of neighborhoods where in other towns ordinary water-closets are commonly a failure and a nuisance. It remains to say that the position chosen for these new closets has been carefully determined by the circumstances of each place where they have been erected, and that peculiar facilities for their being well placed have been obtained by the time of their erection concurring with that of other improvements. The closets that are common to several families are cleansed in rotation by the people using them, and a register is kept of the order in which this should be done. Inspectors visiting the closets every two or three days see that this duty is performed, and are themselves held responsible for any shortcoming. By a little patience and firmness the inspector

succeeds in obtaining the necessary cleansing even among the most intractable classes, with very little assistance from the law. He will, if necessary, wait and see the closet cleaned out by the proper person. Last year only a dozen or so of people were summoned for neglect in this respect, and three of the offenders had to be sent to prison. It will be seen from the drawing that in connection with these closets there is an opening of access to the trough and water supply. This opening is for the scavenger, and the people using the closets have no concern with it. The scavengers are employed by the corporation, and every day they visit each of the trough-closets, unlock the iron door of access, discharge the contents of the trough, flush it out with hose and water, sweep it thoroughly clean, and leave it charged with fresh water for the next twenty-four hours' use. Frost has done no harm to these trough-closets, nor yet to the ordinary siphon-closet with its service-box." "There can be no question of the admirable efficiency of the working of the arrangements above described in the semi-public privies, nor of the recognition by the people of the superiority of the new to the old arrangements. Nor can there be any question that these results are due even more to the management of the whole business by the public authority than to the excellence of the constructive arrangements themselves. And not only is complete freedom from nuisance obtained where formerly filth and stink were universal, but Dr. French states that in 1868, when an epidemic of enteric fever was prevailing in and about Liverpool, 'the only localities that seemed exempt from it were the places occupied by the poor, in which we had removed all the privies and made trough water-closets.'"

Traps.

The use of traps on every waste-pipe inside of a house is a point upon which some difference of opinion is found. If the outside trap upon the main drain is well constructed and ventilated, there is somewhat less importance to be attached to those on each separate waste-pipe. Dr. O. Reynolds, in his little work entitled "Sewer-Gas, and How to Keep it out of Houses," thinks they may in most cases be safely dispensed with. But every waste-pipe becomes lined with a slimy film which, in a climate subject to such summer heats as ours, must needs decompose and give off offensive effluvia. The

difference of temperature in different parts of a house, and the winds outside, would always keep up drafts through waste-pipes if not trapped, passing down one orifice and up another, so that a dwelling-house can hardly be considered safe with us unless traps are provided at every waste somewhere within ten feet of its orifice. The chief objection to traps, except their cost, is that they delay or hinder, to a certain extent, the rapid efflux of the sewage, and keep a small quantity of it shut up to decompose within themselves. Moreover, there is always a column of confined air in a waste-pipe between any two traps in the same line of drainage. Care must therefore be taken to give this column a free connection or vent to the atmosphere, so that its tension may always be in equilibrium with the atmospheric pressure. Without this system of vents the traps are worse than useless, and deserve their name from the disappointment that would be sure to follow their use.

Traps should be used at every waste inside a house.

The best form of trap is that which gives least obstruction to the flow of the sewage, and requires the least quantity of water to insure its seal. All square corners tend to promote an accumulation of sediment or slime, which should be avoided. No form of trap is so simple and so generally efficient as the ordinary S-bend. Its calibre should be about as large as that of the pipe of which it forms a part, with continuous, smooth lines. When a waste-pipe is expected to carry at times a full stream of water, as from slop-sinks, wash-trays, and bowls, there is risk of having the traps siphoned by the last water passing down, unless they be provided with a vent-hole at the top, and this must of course have a pipe to carry its effluvia to the top of the roof.

Form of traps.

The position of traps is a matter of some importance. If close to the orifice, as in the common sink bell-trap, a slight obstruction of sediment will soon serve as a nucleus for a complete dam; but if two or three feet below the orifice, and directly under it, such a slight obstruction would soon be swept away by accumulation of the two or three feet head of water above. The common bell-trap used in sinks, and attached to the strainer, conforms to neither of the above conditions, and is a mere subterfuge. Being close under the strainer, no head of water can accumulate to flush it, and its

Position of traps.

Bell-traps of no use.

large annular depression is a receptacle of rubbish, In fact, it is a mere obstacle to the drainage, so that most cooks lift the cover when they want the water to run off, losing the benefit of both strainer and trap together. A strainer is useful, if screwed fast down, with holes of ample size and number, and a trap made of the S form about the level of the floor, under a wash-tray or sink, will run for years and keep itself clear of sediment, with such a strainer over it.

Workmanship.

Workmanship.

This subject has been mentioned above, but its importance may justify something further. There is generally but one way in which to do a thing properly and well, while there is an endless number of wrong ways into which workmen stumble, through ignorance or recklessness. The importance of having the best quality of work in matters that so nearly affect the health and lives of our families, need not further be dwelt upon. These two facts confront us. Good work is the Alpha and the Omega of good drainage, and good work is too rare an article among the workmen in mechanical trades. Two hundred years ago, the artisans' guilds of the north of Europe developed a degree of skill which often made an artist of the artisan, producing such men as Albrecht Dürer and Peter Fischer, of Nürnberg, while the general emulation led to a degree of excellence in workmanship among large numbers that calls for our admiration, and gave a tone to the civilization of that age well worthy of imitation. Our modern "trades unions," however, seem to have encouraged a lack of thoroughness and lack of interest in the artisan by making too little distinction between the faithful and the unfaithful workman. They combine for mutual protection against evils which they themselves tend to aggravate, and are led by demagogues to fix arbitrary rates of wages, regardless of merit, and encourage no emulation for excellence. The consequences are bad enough, morally, in the lowering of the standard of excellence among artisans, and thereby degrading their intellects, as well as their morals; but the results are particularly disastrous among those who employ artisans to construct such important works as house-drains, for the average householder necessarily depends largely upon the intelli-

Too little emulation for excellence.

gence and skill of the artisan for the perfection of details in such work, concerning which he, the employer, is ignorant. Of course the blundering and reckless apprentice becomes, in time, the ignorant and stupid master-workman, deficient in skill, and confined to routine.

Instances often come to our notice like the following: Some years since the writer employed a man sent from one of the best plumbing establishments in Boston to attach a vent-pipe to a soil-pipe in an old house, which had been built, like thousands of others, without one. The workman was directed to lead the vent into the kitchen chimney-flue, which was conveniently near. This pipe was afterwards seen, entering the side of the chimney-breast, and appeared all right. A few weeks since, a new tenant in the house complained of a bad smell. After searching all about for its source, suspicion led to an examination of the connection of this vent with the chimney. It was found that it *never entered the chimney at all*, but ended with an open mouth in the furring-space between the chimney and plastering! Of course all the gases passing out of this vent, had for years had free access to all the floors of the house. Luckily nobody had had typhoid fever; but no thanks are due to the plumbing for the immunity. Cases of unfaithful work.

Another instance of bad faith in a laborer occurred within a few months in the same street. A recent introduction of aqueduct-water led to laying a service-pipe into a house where it happened to cross under the drain in the front yard. The foreman was cautioned about the drain, which was of Scotch pipe. Some months afterward the occupants of the house found filth oozing through the front cellar wall of the house in midwinter. On digging down through four feet of frozen ground in the front yard, the Scotch drain-pipe was found to have been broken open and placed together again without using any cement, while putting the water-pipe through under it. No mention being made of this fact, it was not suspected till the leakage made its way through the cellar-wall, as above related. Men who are guilty of such acts of bad faith are not likely to be employed further by the same parties; but some more serious penalty than loss of patronage seems to be needed for such cases, where the

results may be the illness and death of their fellow-citizens and neighbors.

Duties of architects.

The want of skill among artisans has been aggravated by a degree of ignorance on the part of architects upon points where they are expected by the community to be experts. It may be urged in their defence that house-drainage is a comparatively new luxury. If so, the architects should be the very class who, from their position, should do the most towards developing its perfection, and not leave it, as is often done, for the confused notions of their clients to work out the details, with the advice of the head mason, neither of whom have probably ever studied the subject from any point of view more comprehensive than from their own limited experience. Much has been written on these subjects; so much, that but few new ideas have been brought forward in this paper. Those who wish to study it further will find it more amply treated by such men as Bazalgette, Latham, Corfield, Eassie, Menzies, Parkes, Reynolds, Waring, Shedd, and others, all in our own language, besides as many more in German and French, wherein the peculiar stand-points of the various writers give rise to different treatment, each suited to its own locality or climate. Besides the study of the experience of others, much remains to be done to adapt means to ends, taking into account the peculiar circumstances governing each case under treatment. What the community has a right to expect, is, that men having in hand the designing and erection of their dwellings, should inform themselves of the conditions on which such dwellings can be made healthy places of abode. If they did this, as a rule, and if artisans had, as a rule, that pride of character and love of good workmanship which is the capital of the mechanic, we should soon see better results.

The writer does not intend to ignore the fact that there are many intelligent and painstaking architects, who have given this subject careful attention; but for some reason or other, there are many of our important buildings designed and erected under the charge of those who are not so distinguished. The following examples came under the writer's notice, within a short time, which may serve to illustrate this point.

A conspicuous public building, costing nearly $200,000, was lately erected under the charge of a leading architect. Like most similar buildings of the present day, it contains a good deal of plumbing. For some time past a nauseous odor pervaded the cellar, which no amount of window opening would remedy. It increased to such an extent as to fill the whole building, and render its occupation sickening. On inquiry, it was found that some square cesspools had been constructed under the cellar floor, into which various drain-pipes entered, and from which a brick drain led, covered with flat stones, an invention of a past age. One of these reservoirs of filth under the cellar floor had been forced to overflow, and had saturated the concrete pavement, after a temporary obstruction of the outlet by a careless workman. Although the obstruction was promptly removed, the stench remained a long time. What good purpose the cesspool served, or is capable of serving, is past comprehension. Its presence is a mere nuisance. The brick drain could hardly have been planned by a person who had taken pains to learn the inherent faults of such structures, and the great superiority of smooth pipes. Mistakes in planning.

Another case: a large public building was recently planned by an architect, chosen by the parties who had the subject in charge, as peculiarly versed in the wants of such an institution as this was to accommodate. The plans showed a brick drain, big enough to crawl through, running under the building for a length of over two hundred feet, too large to be self-cleansing, and, therefore, merely a prolonged cesspool, over which a population of about five hundred persons were to be lodged, those living on the lower story being on a stone floor, resting on the ground, without a cellar or any subsoil drainage, except the brick sewer! This was not all. A large tank or cesspool was provided, just outside the building, in which the whole sewage of this population was delayed, to settle and ferment till convenient times for its removal, although a good sewer was at hand for its immediate and rapid transit to a safe distance.

DUTIES OF PROPRIETORS AND OCCUPANTS.

Duties of proprietors.

However well a system of house-drainage may be planned and constructed, it cannot be expected to be entirely automatic, or to serve its owner for an unlimited period without intelligent supervision. In fact, "eternal vigilance" is the price of safety in such matters in a climate where such violent and sudden changes occur as in ours. Sometimes a trap may freeze in January and dry up in July. Deep frosts sometimes break up drains, and leave them leaky. Rats burrow into and gnaw into drains, if not thoroughly built. The gases given off by sewage often corrode lead pipes, and the ammonia in water-closets corrodes the copper pans. Valves become leaky by wear. Counterpoises get loose. But frost is our greatest enemy; a frozen water-pipe often does much damage, but a frozen drain is the climax of discomfort. With the extended use of plumbing come the increased risks of such mishaps, till many householders long to simplify the apparatus. It cannot certainly be well taken care of in country houses in our climate, unless the occupant knows where to find the pipes, and how to empty them on frosty nights. The risks of leakage of drains are of course very serious, and the difficulty of tracing such troubles to their sources renders it imperative to keep a careful record of their position, and to take the alarm from the only sense by which we can often be led to detect them, acting vigorously to repair the defect when found. Those who do not wish to trouble themselves with such matters had better dispense with drains entirely, and do as in the days of our fathers; viz., carry the refuse-water to a safe distance from the house in pails, where it can be consigned to mother earth. Then they can feel sure that it is beyond the chance of harming them in the house.

Care required.

Dangers from frost.

Record of drains needed.

REPORT

ON AN

OUTBREAK OF INTESTINAL DISORDER, ATTRIBUTABLE TO THE CONTAMINATION OF DRINKING-WATER BY MEANS OF IMPURE ICE.

BY A. H. NICHOLS, M. D.,
OF BOSTON.

REPORT ON AN OUTBREAK OF INTESTINAL DISORDER, ATTRIBUTABLE TO THE CONTAMINATION OF DRINKING-WATER BY MEANS OF IMPURE ICE.

Rye Beach is an attractive and popular seaside resort upon the coast of New Hampshire, about fifteen miles distant from the north-eastern corner of Massachusetts; during the months of July and August of each year it is thronged with visitors from the large cities.

At the beginning of the season of 1875, there broke out among the guests of one of the large hotels of this place, a somewhat extensive, though comparatively mild epidemic. Being the only practising physician in the vicinity, I was requested by the proprietors of the hotel to make a detailed investigation as to the causes of the disorder. The results of this examination revealed a novel and commonly unsuspected source of contamination of drinking-water, and they have, therefore, seemed to me worth communicating to the Board of Health. The disorder in question may be comprehended under the general term disturbance of the digestive system, characterized by a sensation of giddiness and nausea, vomiting, diarrhœa, severe abdominal pain, all of which was accompanied by fever, loss of appetite, continued indigestion, and mental depression. The epidemic, although confined within very limited boundaries, baffled for a considerable time all efforts to trace the trouble to any specific cause; while the *origo mali*, when ultimately detected, proved to be contained in an article of ordinary consumption, usually considered as above suspicion as regards innocuousness. The first few cases coming under observation did not attract particular attention, inasmuch as the symptoms manifested did not differ essentially from those noticed among the visitors in previous years, and

induced by drinking the well-water of the place, which, especially when the wells are low, is strongly impregnated with sulphate of lime, carbonate of lime, and magnesia. It very soon became apparent, however, that the trouble was limited to the inmates of a single hotel, accommodating about 300 guests, whereas the occupants of another public house, containing rooms for about 200, and distant but one-eighth of a mile, were enjoying an absolute immunity from all illness; nor was any similar trouble known among the neighboring cottages, containing at least 500 visitors.

This peculiar grouping of the patients rendered it, therefore, tolerably certain that the whole disorder must be referred to some specific, local origin, to be sought for in the immediate vicinity of the hotel; and popular opinion pointed very strongly, from the outset, to the drinking-water. This was drawn from several wells, all sunk in an elevated ridge, and safely removed from drains, cesspools, dung-heaps, or other source of pollution. It was also ascertained, upon inquiry, that, in some instances, those persons affected, having apprehended trouble from the use of the water, had carefully limited themselves since their arrival to other beverages, but, as afterwards transpired, had not hesitated to use ice, either melted or otherwise.

With respect to the drainage of the house, it appeared that during the previous winter the services of competent engineers from Boston had been secured, under whose supervision an elaborate and complete system of sewerage had been recently constructed, by means of which all the discharge from the various sinks and water-closets was conveyed directly into the ocean. The point of discharge of this sewer was at a safe distance from the house, while the sewer itself was securely trapped and ventilated in such a manner as to preclude the idea of the escape of any foul gas within the house.

Attention was next directed toward the cooking utensils, but all the articles pertaining to the kitchen were found to be scrupulously clean, nor did it appear that any agent or utensil was employed in the preparation of the food which would in any way tend to produce the symptoms complained of. Furthermore, the milk-supply was investigated, and found to be of unquestionable purity.

The process of elimination was in this manner continued, until at length suspicion became directed to the supply of ice furnished to the house. It may be mentioned at this point, that a large portion of the ice consumed in this town is gathered from shallow ponds, formed during the winter by the flooding of meadows, and, therefore, contains as a rule, more or less grass and other vegetable matter, and is consequently far less transparent than the article commonly supplied in our large cities. I was not particularly surprised, then, to find that the ice in this case was rather impure and opaque, and that it contained numerous foreign substances varying in size, and apparently of vegetable origin.

The theory that the outbreak, now increasing in extent and severity, was dependent upon the ice-supply, was suddenly strengthened by some pretty direct evidence, of which the following examples may be given :—

1. A resident of the place, upon being questioned upon the subject, volunteered the testimony that during the previous winter he had taken home some ice from the same pond where the ice-supply of the hotel was obtained, and having consumed a portion with the view of testing it, had experienced nausea and distress for the remainder of the day, which led him to decide that it was unfit for use.

2. Several persons affirmed that they detected a decidedly disagreeable odor emanating from the ice as it melted.

3. Two gentlemen having taken a quantity of ice with them upon an excursion, and drunk the water formed from it, were made violently ill.

4. The atmosphere of the house in which the suspected ice was stored was found to be decidedly offensive.

5. When some of the melted ice-water was poured into a glass, and held in front of a dark-colored object, a strong light striking the glass from one side, it was found to be decidedly discolored, and charged with suspended matter.

A visit was now made to the pond, and the condition of things here found removed all doubt as to the exceptional foulness of the water from which the ice was formed.

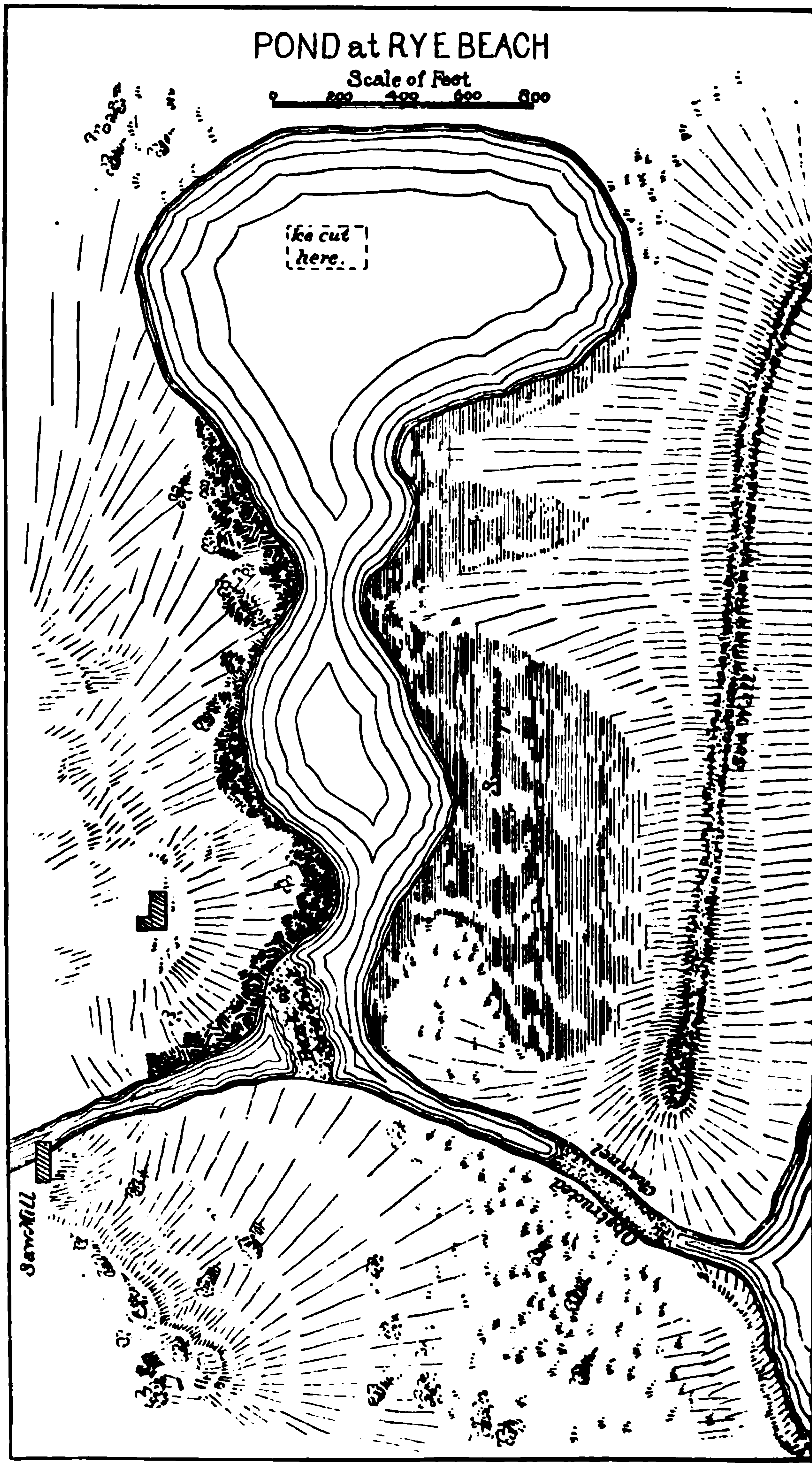
This pond is a flooded marsh, of irregular outlines, about two-thirds of a mile in length, and varying in width from 200 to 800 feet, with a uniform depth of about two feet. The

source of the water-supply was a small brook entering the lower end of the pond (bringing down all the sawdust from two neighboring saw-mills), and several springs said to be situated at the upper end. There had formerly existed an artificial channel, by means of which was maintained a direct communication between the pond and the ocean; but for the past two years this channel had been filled up with sand and stones thrown up during heavy storms by the action of the sea, which drives in here with extreme violence. Of late, therefore, the water of the pond has become practically stagnant, although a small quantity constantly percolates a bank of gravel separating the pond from the ocean.

A glance at the lower end of the pond was sufficient to demonstrate the source of the foulness of the water, for at this point, a space of about 500 long and 150 feet wide, directly in front of the mouth of the brook, was occupied by a homogeneous mass of putrescent matter, composed of *marsh mud* and *decomposing sawdust.* The water in the vicinity of this bank was discolored black, and when stirred up emitted an intolerably offensive odor. Several large houses are situated at no great distance from this end of the pond, the occupants of which, upon being questioned, asserted that when the water was stirred up by the rowing of boats, or ruffled by a wind blowing in the direction of the houses, the air was not unfrequently polluted to such an extent as to render it necessary to close the windows. Of course there could be no question but that this foul matter held in suspension in the water was conveyed by currents and winds to every part of the pond, and in sufficient quantity to render the water in every part absolutely unfit for drinking purposes.

In order to obtain further evidence as to the admixture of this foul matter with the ice, a quantity of the ice having been cleansed from all surface impurities was placed in a tub to melt, and the water thus obtained was poured into a fresh demijohn, sealed and forwarded for analysis to Prof. W. R. Nichols, who reported as follows:—

"The water contains in suspension a considerable quantity of vegetable matter more or less decayed, and possesses a slightly disagreeable odor, which becomes more evident if the water is warmed.


POND at RYE BEACH
Scale of Feet
0 200 400 600 800
Ice cut here.
Saw Mill
Obstructed Channel

"Of the organic matter which is suspended in the water, and which may be removed by filtration, a portion, consisting of the larger and heavier particles, settles somewhat readily. Another portion, being more finely divided, remains for an indefinite time diffused through the water, and would be drunk by any one using the ice in the ordinary way.

"I do not think it unreasonable to suppose that the presence of this decaying organic matter may have been instrumental in bringing about the unpleasant results you have observed."

A sample of water was likewise taken for examination from the pond in question. This sample was obtained from the central portion of the pond, in the early morning, when no air was stirring, and the water being quite calm and undisturbed by undercurrents, the greater portion of any matter held in suspension would at that time be precipitated to the bottom of the pond. Consequently, the sample taken would represent the purest water obtainable from the pond under any circumstances.

The numerical results of these analyses are herewith appended. For the purpose of affording a means of comparison, there are also presented the results of analyses of a sample of ice supplied by the Boston Ice Company, and of the Cochituate water.

The subjoined sketch of the pond (drawn by Edward K. Clark, C. E.,) will serve to convey an idea of the general outline and character of the pond, the location and relative extent of the bank of sawdust and marsh mud by which the water was fouled, and the portion of the pond from which the ice was taken.

The proprietors of the hotel, impelled by a proper sense of the responsibility resting upon them, rendered willing assistance in ferreting out the source of the trouble, and as soon as suspicion was directed towards the ice, its further use was promptly prohibited. Coincident with this disuse of the ice, there was observed an abrupt amelioration in the symptoms of nearly all who had hitherto been ill, while during the remainder of the season, no fresh cases of this character are known to have occurred.

The evidence thus collected seems to render it almost

certain, that the illness in question was induced by the consumption of ice contaminated by decomposed organic matter.

As to the actual, or relative, number of those made ill in this manner, no exact estimate can be made, for the symptoms were, as a rule, not sufficiently severe to necessitate the aid of a physician.

As an approximate estimate of the extent of the mischief produced, it may be said in round numbers, that the ice was consumed in variable quantities during a period of six weeks by five hundred individuals. Of these, twenty-six adults were known to manifest grave, continued, and characteristic symptoms. A large number, probably the majority, of the guests drank the contaminated water with apparent impunity. In some, although decided illness was induced during the first two or three days after their arrival, an habituation to the water seemed to be afterwards acquired, and they enjoyed a subsequent immunity from all trouble. In the case of several, on the other hand, the stomach seemed to resent with ever-increasing emphasis the presence of the foul water, nor was relief obtained until after the patients had quit the place. Thus many who had come from a long distance with the hope of strengthening and improving their physical condition, returned home depressed, and without even having preserved the health they previously had.

It is worthy of remark, that no person under the age of ten was known to be affected by the impure ice.

Great responsibility devolves upon those who undertake to provide food and drink for large numbers of individuals, and to such the above experience inculcates the importance of giving especial attention to the purity of the drinking-water, and guarding against every possible source of contamination.

The notion that ice purifies itself by the process of freezing, is not based upon trustworthy scientific observation. On the contrary, it is utterly wrong in principle to take ice for consumption from any pond the water of which is so fouled as to be unfit for drinking purposes.

Numerical Results of Analyses.

COMPONENT PARTS.	Ice taken from Contaminated Pond at Rye Beach.*				Ice supplied by Boston Ice Company.†	
	Results expressed in parts per 100,000.		Results expressed in grains to U. S. gallon.		Results expres'd in parts per 100,000.	Results expres'd in grains to U. S. gallon.
	Unfiltered.	Filtered.	Unfiltered.	Filtered.	Unfiltered.	Filtered.
Ammonia,	0.0208	0.0213	0.0121	0.0124	0.0045	0.0026
Albuminoid ammonia,	0.0704	0.0165	0.0410	0.0096	–	–
Inorganic matter,	7.80	6.88	4.55	4.01	0.45	0.26
Organic and volatile matter,	5.72	2.84	3.33	1.66	0.31	0.18
Total solid residue at 212 deg. Fahrenheit,	13.52	9.72	7.88	5.67	0.76	0.44
Chlorine,	–	3.23	–	1.88	Trace, less than 0.02	Less than 0.012
Oxygen required to oxidize organic matter,‡	–	0.334	–	0.495	0.033	0.019

* Small amount of nitrates. † Trifling amount of suspended matter. ‡ Determined by permanganate of potash.

60

Numerical Results of Analyses—Continued.

COMPONENT PARTS.	WATER TAKEN FROM POND AT RYE BEACH.*		Cochituate Water. Mean of a number of determinations. Results expressed in grains to U. S. gallon.
	Results expres'd in parts per 100,000.	Results expres'd in grains to U. S. gallon.	
Ammonia, ...	0.0197	0.0115	0.0020
Albuminoid ammonia, . .	0.0597	0.0348	0.0068
Inorganic matter, . . .	64.96	37.88	1.61
Organic and volatile matter, .	8.00	4.66	1.22
Total solid residue at 212 deg. Fahrenheit, ...	72.96	42.54	2.83
Chlorine, ...	34.00	19.83	0.18
Equivalent to chloride of sodium, ...	56.03	32.68	-
Oxygen required to oxidize organic matter, . . .	1.28	0.75	-

* Residue blackens strongly when heated. Evidently a large amount of organic matter.

REPORT

ON THE

REGISTRATION OF PREVALENT DISEASES.

By F. W. DRAPER, M. D.,
Of Boston.

REPORT ON REGISTRATION OF PREVALENT DISEASES.

The desirability of a trustworthy method for the registration of prevalent diseases is undisputed. Sanitarians have repeatedly expressed the want, but have failed hitherto to realize its fulfilment. They know how much greater would be their power to protect the public health, if data of the local development and progress of disease were promptly afforded to them. They recognize the fact that the utility of such a registration is amply illustrated in the control which boards of health exercise during invasions of small-pox prompt measures of prevention by isolation being thereby made possible for the defence of the entire community. In a still broader sense, they see the great advantage which would result from the opportunity to study the rise and fall of epidemics, and the development of diseases whose cause lies in local and preventable conditions.

Hitherto health authorities have relied on the registration of deaths as affording a basis for their active operations in behalf of the public welfare, as well as for generalizations in sanitary science. A persistently high rate of mortality is an indication that something is wrong in the sanitary condition of the community reporting it; it is a signal that so far as that region is concerned, influences are at work which demand speedy investigation and, if it be possible, prompt removal. Therefore the registration of mortality has always been acknowledged as an invaluable adjuvant to sanitary administration.

But it is obvious that the death-rate does not represent the actual state of the public health, the real amount of sickness, or its real character at any given time in any community.

An entire hamlet may be smitten by an epidemic which makes no impression on the bills of mortality. The schools of a township may be forced to take an unseasonable vacation by a general invasion of whooping-cough, which may cause a comparatively small number of deaths. Mild scarlatina, or diphtheria, or even small-pox may sweep through a village and be the occasion of only a few funerals. On the other hand, an exceptionally severe outbreak of infectious disease may be attended with a fatality out of all proportion to the number sick, and thus become the source of erroneous inferences. So that it seems eminently desirable that a registration of diseases should in some way be put into operation, not to take the place of mortality-registration, but to supplement it.

To the public, as well as to the health-authorities, an accurate knowledge of the prevailing diseases is of evident value. An official bulletin, issued at stated intervals, declaring what acute diseases are present in a specified section, and in what part of that section they are most rife, has a double usefulness: it warns well people to avoid the risk of exposure in any specially infected locality, while it prevents the ill effect of sensational items, which are ever on the alert to startle newspaper readers by their alarming assertion that this or that dreaded and dangerous malady is "raging" in some community which is only measurably affected, or, it may be, is wholly exempt. If it were possible to publish daily records of the relative prevalence of the more important acute diseases, and of their comparative gravity, from returns gathered and compiled upon authority, the people might escape the apprehension and the alarm fostered by paragraphs for which nobody is responsible.

The analogy between such a scheme and the already established system of weather-reports will at once occur. The eminent usefulness of the work done by the Signal Service cannot be gainsaid. Its value to commerce, to agriculture, and to the conduct of ordinary affairs, has been fully tested. The "weather probabilities" have become an important feature of the daily news, and thousands of people are accustomed to shape their plans according to the prognostications of the chief of the bureau. Already we have intimations of

a greatly extended operation of the system of weather-reports begun so successfully in this country; the time will presently come, when an international bulletin of meteorological observations, taken simultaneously at many stations in the northern hemisphere, will furnish special means for the development of this department of scientific study.

In like manner, the prevalence of endemic and epidemic diseases may be registered. Large areas of territory may be included in the field of observation, and bulletins issued by a central authority may give timely warning of the rise and spread of zymotic affections. Just as the "cautionary signal" now tells the mariner or the traveller that a storm is coming, so in the future will the official word of the registrar tell the public of the existence of infectious and contagious diseases, their gravity, and their progress. Indeed, it is not too much to predict that "probabilities" may yet be cast with some degree of precision, as we advance in our knowledge concerning epidemics. The manifold directions in which such a system may prove useful in gathering facts concerning epidemiology, in staying groundless alarm, in pointing out localities to be avoided, in indicating specially threatened places, need hardly be mentioned farther.

Yet it must be confessed, that there are many and serious difficulties *at present* in the way of a practical realization of such a plan. Some of these obstacles are inevitable; others would disappear as time introduced more perfect methods of registration, and diminished the friction of new machinery. It is proper to allude briefly to some of these hindrances.

It is obvious that the registrar of prevalent diseases is obliged to depend for his working material upon the medical profession; his information must come from physicians upon whose punctuality and uniform fidelity the success of the entire business relies. The law is not his ally in this matter, as in the case of the kindred registration of mortality; the labor attending the gathering of the preliminary facts must, therefore, be entirely voluntary and public-spirited. But it is impossible that the entire medical profession, including all persons styling themselves "doctors," could be enrolled in the service; and on many accounts it is well that it is so, because, as is amply illustrated in mortality registration, the

certificates furnished by the numerous company of pretenders, to whose ministrations a pretty large minority of the people submit themselves in times of sickness, are of doubtful value, and do not supply reliable data for sound reasoning. A purely ideal system for registering prevalent sickness would involve the recording of every case of acute disease, whether it were under the care of persons representing one or another degree of medical skill, or indeed of those without any degree at all. Such a comprehensive plan, even supposing it to be desirable, is not practicable. Reliance must therefore be placed upon a selected number of observers, who will regularly return the required facts. The registrar will aim to secure the coöperation of the best physicians, those at once the most accomplished and the most busily engaged in their art. He will be fortunate if those of his first choice do not decline his overtures, through reluctance to accept another draft upon their professional charity and good-nature. Any scheme of this sort will be strong, and its results valid in proportion to the trustworthiness of those who are its practical supporters; success depends more on the character of the observers, than upon their number. The first difficulty, therefore, in the way of this registration, is the selection of men best fitted to perform the primary service; the second and greater difficulty is to enlist these volunteers in the corps of observation.

But supposing the corps to be sufficiently and satisfactorily filled, the physicians composing it representing the best possible quality as regards medical intelligence, extent of observation, fidelity, the next obstacle lies in the fact that the matters to be reported upon are not of an absolute character. The meteorological observer is sure of his weather record; his thermometer, and barometer, and anemometer indicate to him positive conditions, about which there can be no mistake, the proper precaution being taken, of course, concerning the accuracy of the instruments. But the clinical observer deals with matters far more subtle and difficult; the reliability of his record of observations depends upon his own acuteness and judgment. He reports the presence or absence of diseases whose diagnosis is not always easy. His opinion of the nature or gravity of any case or series of cases may be quite

different from that of his neighbor. What is diphtheria to one observer, is croup or simple sore throat to another; what is febricula to one, is typhoid fever to another; what is cholera infantum to one, is infantile diarrhœa to another; what is influenza to one, is bronchitis or severe catarrh to another. For this diversity there is no radical remedy. It is the source of a considerable margin of error in the registration of mortality, affecting the causes of death; it is the possible origin of a still wider range of uncertainty in the results of any scheme for registering diseases which do not afford, in their fatal termination, an additional indication for diagnosis. Our chief safe-guard is again to be found in the known skill and reputation of the observers.

The liberality of the State Board of Health permitted during the year 1875 a plan for registering prevalent diseases in Massachusetts to be subjected to a practical test. The plan was not a pretentious one: it was offered as an initiatory experiment in a field of sanitary statistics hitherto unproductive. The purpose was to break the ground, in the hope that other workers might be tempted to carry forward and perfect a project believed to contain undeveloped elements of value and importance to the public welfare. It is the main object of this paper to report what has been done, the methods, and the results.

For the purposes of the plan devised, the State of Massachusetts was divided into seven sections of unequal size, but of distinctive topographical characters. The hill country of Berkshire formed one section. The second region comprised the counties of Franklin, Hampshire, and Hampden, the "valley" section, traversed and drained by the Connecticut River. The county of Worcester constituted the third or "midland" section. The "north-eastern" section included all of Essex County, and all of Middlesex County except eleven towns and cities embraced in the fifth section. This latter, the "metropolitan," contained Boston and its suburbs, the northern boundary being the valley of the Mystic River, and the southern the Neponset River. In this section were included, besides the city proper, with its recently acquired outlying territory, the following: Hyde Park, Brookline, Newton, Watertown, Belmont, Cambridge, Arlington, Som-

erville, Melrose, Medford, Malden, Everett, Winthrop, and Chelsea. The "south-eastern" section, the largest in area, consisted of the counties of Norfolk (the towns of Hyde Park and Brookline excepted), Bristol, Plymouth, and Barnstable. The islands of Martha's Vineyard and Nantucket constituted the seventh, or "island" section. These several territorial divisions were made without regard to their extent, or to the distribution of their population, but solely with reference to their general characters, as regards situation and surface.

The field of observation having thus been divided, the physicians were selected in each district to perform the part of observers. The principle of the choice has been intimated. The aim was to secure the coöperation of regularly educated, intelligent medical men, whose field of practice was so distributed as to enable them in the aggregate to give a comprehensive and accurate weekly conspectus of the diseases prevalent in the entire State. In cities whose sick poor were attended to by means of an organized gratuitous dispensary service, the physicians of the visiting staff were regarded as particularly desirable reporters, for the reason that the patients under daily observation were so numerous, and of such a character, as to have considerable influence in determining the relative prevalence of acute diseases in their localities.

The project was introduced to the attention of the profession in November, 1874, the following circular being mailed to one hundred and sixty-eight regular physicians:—

COMMONWEALTH OF MASSACHUSETTS.

State Board of Health,
Boston, Nov. 1, 1874.

Dear Sir:—The State Board of Health is very desirous of getting weekly information of the diseases prevalent in all parts of Massachusetts. The object is certainly one of great importance,—positive knowledge of the health of the people, as well as of the diseases which, at any time and place, are present, or which threaten to extend as epidemics.

In order, however, to attain this end, the board will need the coöperation of a large and select number of physicians, in full general practice, in various parts of the State. We therefore take the liberty of asking whether you will consent to be one of this

number,—to report weekly, during the next year (1875), the diseases prevalent in your vicinity. The inclosed sample postal card will indicate the proposed method; it will be observed that an endeavor has been made to reduce to the minimum the expenditure of time and trouble incident to the service asked of busy medical men.

The board has appointed Dr. F. W. Draper, of Boston, to be the registrar of this new Bureau of Health Correspondence. He will compile from the returns received a concise weekly bulletin of prevalent diseases, to be reported to the secretary of the board, and published, with appropriate comments, for the information of the people. At the end of the year, a summary of the accumulated observations will be prepared for publication in the annual report of the board.

If the board is successful in securing the coöperation of physicians in the accomplishment of this plan, the practical results will be of essential value, not only to the State at large, but to private individuals. To medical men, in particular, such a weekly synopsis of prevalent diseases would be possessed of obvious interest. It is not out of place to remark, also, that the present scheme is the first practical attempt in any part of the world to make a systematic weekly registration of diseases. It is hoped that you will consent to assist the board in executing a purpose which is capable of being developed to very useful ends. If you will please to signify your willingness to undertake the service alluded to, the proper blanks will be forwarded.

We have the honor to be, very respectfully, yours,

Henry I. Bowditch,
David L. Webster,
J. C. Hoadley,
Richard Frothingham,
T. B. Newhall,
R. T. Davis,
Chas. F. Folsom,
Members of the State Board of Health.

To this preliminary request for coöperation, one hundred and fifteen physicians responded affirmatively. In March, 1875, this number was increased by the enlistment of the aid of seventy-nine additional physicians. These one hundred and ninety-four medical men were supplied from time to time with postal-card blanks, to be filled and forwarded to the

registrar. This blank form, of which a copy is here given, was intended to procure the maximum of information with the least amount of machinery and detail.

F. Report of Diseases prevalent during the Week ending Saturday, ... 1875.

☞ Please erase the names of Diseases NOT prevalent, and indicate the relative gravity of PREVALENT diseases by a cross (×) under "Mild" or "Severe," as the case may be; basing the Report, not alone on the actual cases in the reporter's practice, but also on a general knowledge concerning his vicinity. Please mail the card as soon after FRIDAY of EACH WEEK as is convenient.

	Mild.	*Severe.*
Bronchitis		
Cholera Infantum .		
Cholera Morbus . .		
Croup (*Membraneous*) .		
Diphtheria		
Diarrhœa		
Dysentery		
Influenza		
Measles		
Pneumonia		
Rheumatism		
Scarlatina		
Small-pox		
Typhoid Fever . .		
Whooping-cough .		
....		
....		
....		

Remarks..

....

....

.... *M. D.*

If more particulars had been called for, necessitating an additional outlay of time and thought on the part of the active practitioner, much less would have been gained in the end. The form has served admirably throughout the year. Future experience may indicate the time when more elaborate data can be asked for and obtained; the point has not yet been reached when a state commission can draw from an overworked profession long-continued gratuitous service, unless that service

be of the simplest nature, and to secure most useful ends. It is a pleasure in this connection to testify to the faithfulness and uniformity with which the physicians have discharged their promise to coöperate in this work. It was to be expected that some would fail and drop out of the ranks before the year was ended; but to the large majority, the registrar feels indebted for well-sustained assistance. Without this aid, the plan would have come to naught; to it the experiment owes nearly the whole of its success. If one would seek for some sign that the registration of diseases is a desideratum, and that the present method has in it some quality of favor, he might find such evidence in this ready response and long-sustained support on the part of many of the best representative physicians of the State.

The reports returned at the end of each week were assorted by districts, the initial letter at the left upper corner of each card being designed to facilitate that work. The diseases reported by each section were then compiled from the cards, and a percentage computed between the number reporting each disease and the whole number reporting for that week for that district; thus, if from the midland section, in a given week, twenty-five (25) cards were received, of which eighteen (18) returned pneumonia as prevalent, the percentage for pneumonia for that week and that section would be seventy-two (72). Inasmuch as the number reporting from week to week necessarily varied somewhat, this computation of the percentage would appear to show better than any other way the relative changes in the prevalence of diseases. All the sections having been analyzed in this way, the summary for the State at large was obtained in a similar manner by aggregating the returns. The results of the analysis for each section and for the State were transferred to charts, which presented to the eye a graphic picture of the prevalence from week to week of acute diseases, the regular curves giving a satisfactory notion of their development and decline.

One feature of the work, and that by which the public has known of its progress, has been the weekly bulletins. From the cards, and from the charts, was readily made a brief summary, setting forth the diseases prevalent in the various parts of the State, with a comparative record giving the increase or

decline of the more dreaded affections. This weekly bulletin was published simultaneously on Thursday mornings throughout the year in the "Boston Medical and Surgical Journal," and in the Boston "Morning Journal." A single specimen will suffice to show the general character of these announcements:—

"The following is a bulletin of the diseases prevalent in Massachusetts during the week ending January 16, 1875, compiled under the authority of the State Board of Health, from the returns of physicians representing all sections of the State:

"In Berkshire, pneumonia, rheumatism, bronchitis, and typhoid fever. Diphtheria and croup are less prevalent.

"In the Connecticut Valley, bronchitis, influenza, rheumatism, diphtheria, pneumonia, whooping-cough, and croup; scarlatina is less prevalent. One physician in Springfield reports meningitis.

"In the midland section, mild bronchitis, severe pneumonia, influenza, rheumatism, whooping-cough, scarlatina, and diphtheria. Erysipelas is reported as 'epidemic' in the northern part of Worcester County.

"In Middlesex and Essex counties, influenza, bronchitis, scarlatina, rheumatism, pneumonia, and whooping-cough. Measles and diphtheria are subsiding.

"In the metropolitan section (Boston and its suburbs), bronchitis, pneumonia (not fatal), rheumatism (sub-acute), measles, scarlatina, influenza, and whooping-cough. Diphtheria and tonsillitis appear to be subsiding together.

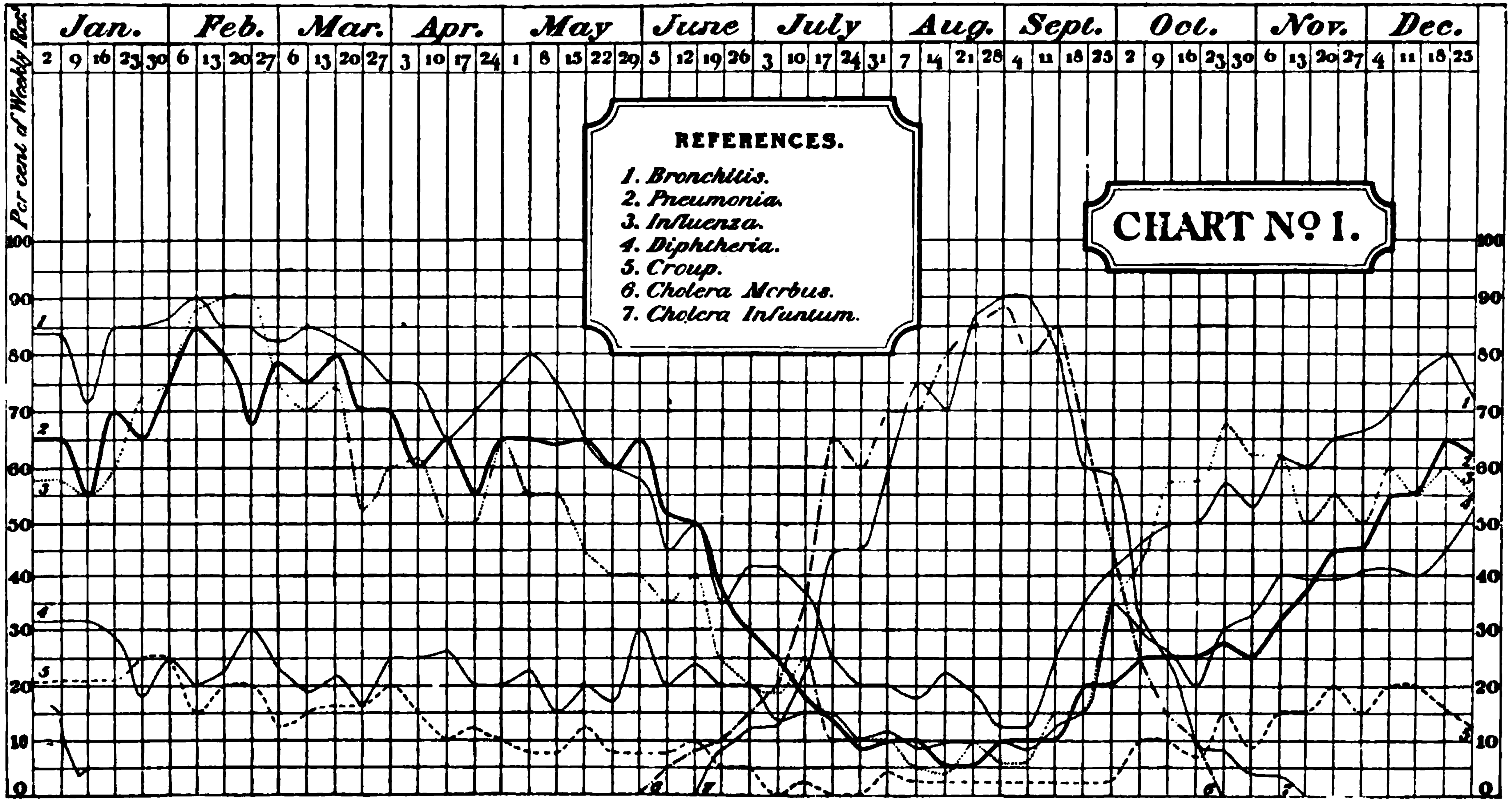
"In the south-eastern counties, mild bronchitis, influenza, pneumonia, rheumatism, whooping-cough, and croup. Scarlatina is less prevalent.

"It appears that bronchitis, pneumonia and rheumatism prevail in all parts; croup and diphtheria are most prevalent in the Connecticut Valley; scarlatina is in the midland, north-eastern and metropolitan sections, its type being generally mild; whooping-cough prevails mostly in the rural sections.

"Since last week there has been a decline in the following: Measles, diphtheria, and tonsillitis. Bronchitis, influenza, pneumonia, rheumatism, scarlatina, and erysipelas show an increased prevalence. Croup and whooping-cough are the same as at last report.

"F. W. Draper, M. D., *Registrar.*"

But the weekly statements do not exhaust the account of the fruits which the scheme has made apparent; the bulle-



NOTE.—This chart is to be read as follows: "For the week ending January 2, 1875, 84 per cent. of the observers returned bronchitis as prevalent; 65 per cent. reported pneumonia; 57 per cent. reported influenza; 32 per cent. reported diphtheria, &c."

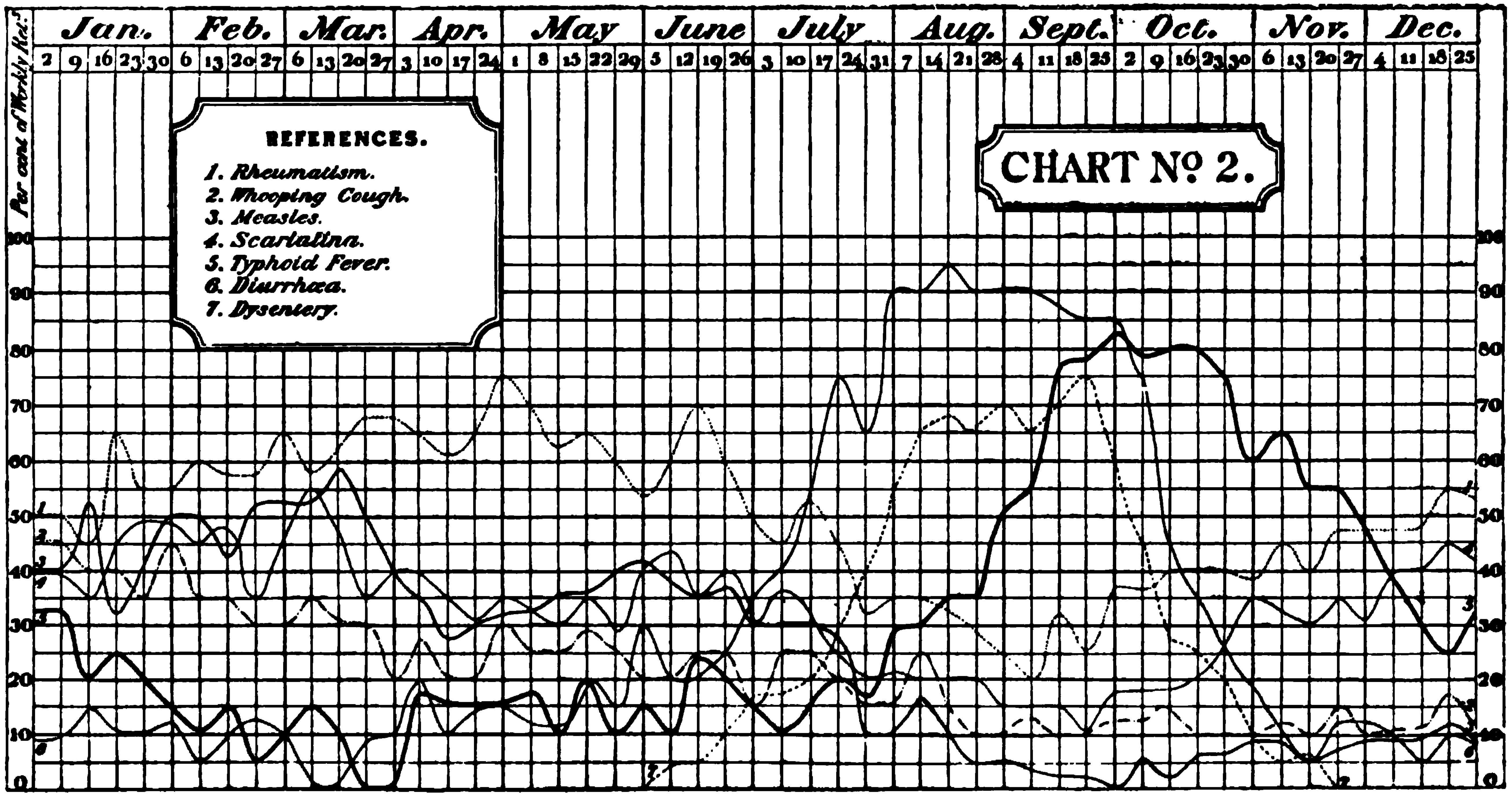


CHART No. 2.
REFERENCES.
1. Rheumatism.
2. Whooping Cough.
3. Measles.
4. Scarlatina.
5. Typhoid Fever.
6. Diarrhœa.
7. Dysentery.
Per cent of Weekly Ret.
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
0 10 20 30 40 50 60 70 80 90 100

tins served their purpose, and fulfilled their end, as soon as they were published; they were essentially ephemeral. It is possible to gather from the returns some results of a more permanent value. The geographical distribution of non-fatal diseases, their development considered with relation to the changes of the seasons, their more or less distinctly defined local manifestation, their relation to meteorological variations, are all capable of being demonstrated. The accompanying charts are intended to show the relative prevalence of acute diseases in the State at large during the year. It will be useful to add a few notes concerning the different sections whose charts are not introduced.

Berkshire.—During January, croup and diphtheria were quite prevalent; but they subsided as the spring advanced, and remained absent until October, when a slight accession occurred. Influenza and bronchitis were present throughout the winter and spring months, but they disappeared before the first of June, to reappear in late autumn; pneumonia and rheumatism followed a similar course. There was some typhoid fever in the first three months of the year; it disappeared in April, to return in September, and continue through the autumn. The diarrhœal diseases of summer began their invasion at about the first of August, considerably later than in some of the more populous sections; they subsided in the second week of October. Whooping-cough was never entirely absent. Measles had a very limited course during February, March, and April, and it reappeared in some parts in December. Scarlatina was present (but not prevalent) during April, May, and June. In April, the town of Lee reported the presence of small-pox.

The Valley of the Connecticut.—This section began the year with bronchitis, diphtheria, pneumonia, and rheumatism as its prevailing diseases. In February, bronchitis was joined by influenza, and both held sway till the middle of March, when they subsided together, reaching their point of least prevalence in midsummer, but returning with October, and continuing to prevail quite generally during the rest of the year. Diphtheria was at no time wholly absent; it was most prevalent in January, least prevalent in August; from the first of October to the close of the year it was again quite rife,

especially in the cities and larger towns. Pneumonia and rheumatism kept their course together from January to June, when the former subsided while the latter continued; after the first of October both diseases increased in prevalence till the end of the year. Measles had a limited course in January and February, and again in May and June, but it was never epidemic, as in some of the more eastern parts; in the late autumn, the town of South Hadley suffered from the combined presence of measles and diphtheria. Scarlatina maintained its hold throughout the year, but it was only moderately prevalent. Small-pox was reported in the spring by a few towns (Holyoke, Easthampton, Wilbraham, Huntington), but the disease did not extend. The summer diseases (diarrhœa, dysentery, cholera infantum, and cholera morbus) first appeared in the last week in June, reaching their maximum prevalence in August, and disappearing in October, diarrhœa being the first to enter and the last to leave the stage. Typhoid fever was first reported in the last week of July; it steadily advanced till the last week of September, and thenceforward it declined; in the towns along the banks of the river a remittent type of fever was observed. Cases of cerebro-spinal meningitis were reported in the earlier months of the year as present in the northern parts of this section (Shelburne, Ashfield, etc.).

Midland (Worcester County).—Bronchitis, influenza, pneumonia, and rheumatism held the highest place in the scale from January to June; measles and scarlatina came next in the list, the former reaching its highest point in February, and continuing till August, the latter having its maximum in March, but prevailing to a limited extent throughout the year. Whooping-cough was reported through January, February, and March. Typhoid began in the last week of July, and was most abundant in October; it held the highest place in the list in that month. Diarrhœa led the van of the summer maladies, beginning in June, and followed a fortnight later by dysentery, cholera morbus, and cholera infantum, their maximum prevalence being in August and September. In October, bronchitis and influenza reappeared coincidently with the occurrence of epizoötic catarrh. Several towns in the Blackstone Valley reported small-pox at the close of win-

ter, and in the spring. Millbury reported an unusual number of puerperal fever cases in May. "German measles" (rötheln) was frequently observed in the spring.

North-eastern.—The diseases of the respiratory organs (bronchitis, pneumonia, and influenza) held sway till June, when they subsided, to return in October, and continue to the end of the year. Measles and scarlatina were very general throughout the earlier half of the year, and the autumn witnessed their revival. "German measles" was frequently reported in the spring. Whooping-cough was prevalent during the first six months, but it disappeared in midsummer. Rheumatism kept its hold throughout the year. Diphtheria was more common during the last three months than at any other time; it was not as rife in this section as in some other parts of the State. The last week in July was the time at which the diseases of summer began; their highest point was reached in September; their disappearance occurred in the last week of October. Typhoid fever commenced in August, was most prevalent in September, and declined in October. In the spring, isolated cases of cerebro-spinal meningitis were reported as present in certain towns in Essex County. The year has not been an unhealthy one in this section; influenza, measles, and scarlatina have been the only diseases which had a prolonged or very general prevalence.

Metropolitan.—The first returns of the year indicated the prevalence of bronchitis, measles, pneumonia, rheumatism and scarlatina. These diseases kept their place at the head of the list until June. In February they were augmented by an epidemic of influenza, which continued till the middle of May. Scarlatina reached a high point in March, then subsided during the summer months, to return in October, and to become more prevalent in December than at any time during the year. Diphtheria secured a hold early in the year, declined somewhat in the spring and summer, but reappeared in September, and was quite rife from that time until the end of December. Tonsillitis was common during the first quarter. Whooping-cough prevailed to a limited extent during the first four months. The group of summer affections began to develop in the last week of June, was most rife in August, and subsided in the early part of October.

Typhoid was never absent during the year; its increase began in the middle week of August, the highest place being reached in the middle of October; it was not as prevalent here as in some of the rural sections. At the close of the year, bronchitis and pneumonia headed the list of prevalent diseases, and diphtheria and scarlatina came next in order. Rötheln prevailed quite generally in the spring, accompanying the epidemic of measles, and appearing in this section before developing elsewhere. Epidemic catarrh occurred in October, coincidently with the epizoötic disease.

South-eastern.—Bronchitis and influenza were rife from January till June. Pneumonia and whooping-cough prevailed extensively from February to April. Diphtheria was present from January to April, and again in the autumn, its maximum being in October; it was less prevalent than in most other parts of the State. Measles prevailed in March, but not at any time so extensively as in the metropolitan and north-eastern sections. Scarlatina was present during the first six months, and again in the last quarter, but not extensively. July witnessed the accession of the diarrhœal diseases, August their maximum prevalence, and October their decline. September and October were the months in which typhoid fever was the most rife. In March and April, small-pox was in Fall River, but it did not extend.

The towns upon the islands in Martha's Vineyard have been comparatively exempt from acute diseases throughout the year.

The charts of the various sections enable us to trace the wavelike progress of contagious diseases. It is made apparent that the strictly contagious affections do not assail large areas of territory coincidently, but that their invasion is progressive. Thus, measles was epidemic in Boston in January, February, and March; it was hardly mentioned in the returns from the north-eastern and the south-eastern section before March, and while it was subsiding in Boston, it was most abundant to the north and the south of that city. March, April, and May found it in the midland section, while May and June were the months in which it was most prevalent in the valley of the Connecticut.

Cerebro-spinal meningitis occurred sporadically throughout

the year in all the sections; but it did not have, at any time, or in any place, a very marked prevalence. Many of the observers noted its coincidence with bad drainage and other unsanitary conditions.

The distinction of diseases, according to their type, as mild and severe, has been observed by those making the weekly returns. It is impossible in this summary to make use of this discrimination, but in the course of the year it has been very useful in determining the relative gravity of the various affections in regard to time and place. It may be stated in a general way, that in all parts of the State, the year through, the milder forms of acute diseases have predominated.

The sensitiveness of the public health to weather-variations has been shown repeatedly by means of the weekly returns. A sudden change in temperature or in humidity, has again and again indicated its effect upon the amount and gravity of the prevailing diseases. A single instance, which many persons in Massachusetts will recall, may be cited as an example of this. The fourth week in April, the week in which the centennial celebrations at Concord and Lexington occurred, was marked by a severe cold snap after an interval of mild weather. The sickness returns for the week represented a very decided increase of acute diseases; bronchitis, influenza, rheumatism, pneumonia, whooping-cough, measles, scarlatina, and sore throat were returned as being much more prevalent. It is one of the advantages of such a system of sickness-registration that it shows at any time, and without delay, the effect of weather-changes, making a far more prompt and satisfactory exhibition of the influence of such changes upon the public health, than is possible with the mortality-table which gathers the more distant, indirect, and partial results of the same phenomena.

It is to be remarked, in conclusion, that the method of sickness-registration, tested in Massachusetts during the last year, has surpassed the expectations of many who were interested in its trial.* Experience has discovered certain defects

* When it is remembered that the State contains a population of 1,651,912 persons, living in 19 cities and 322 towns; that the average weekly number of physicians who have reported in season for the published bulletin, concerning the prevalent sickness in all these cities and towns, and of all these

in it, which, in future, might be avoided. The year's work has demonstrated the willingness of the medical profession to coöperate in such a registration, and this fact alone is a significant result of the trial. It is to be hoped that the recording of prevalent diseases may yet become as indispensable a department of the public service as is the registering of mortality at the present time. It matters little what the details of the method are, or who originates them, if only they are practicable, and their results are good. The need of such a record is undeniable; its fulfilment is a question of time. In the words of a distinguished leader in sanitary reform, "Registration of deaths represents the wrecks which strew the shore, while that of sickness would tell us of the coming storms, and enable us to trim our vessels to meet them. Till we have such a system of disease-registration, public health cannot be administered with full intelligence."*

people, has scarcely reached six scores, and that these physicians have based their returns, not on data of absolute statistical accuracy, but on their general knowledge of what was going on around them, the results of the year's experiment may seem insignificant to the critical. It is frankly admitted that the results of this single year's work are without much value in themselves, but it is insisted that the method of registration should not be judged according to the fruits of this short period of trial. Two measures at once suggest themselves for rendering the plan more effective in future, and both these measures are practicable: first, to enlarge the number of weekly medical reporters; and, secondly, in proportion as that is accomplished within the limits already alluded to, to call for statements which shall more fully satisfy the requirements of statistical correctness. When the fact is recalled, that the registration of vital statistics has required more than a quarter of a century to attain its present place, it can scarcely be expected that any registration of sickness can come full panoplied into being, or that its first fruits will be entirely satisfactory.

* Right Hon. Lyon Playfair, F. R. S. Address on Sanitary Reform. 1874.

HEALTH OF BOSTON.

1875.

By F. E. OLIVER, M. D.

HEALTH OF BOSTON.*

The somewhat confused state of the registration department, arising from contemplated changes in the mode and management of the mortality registration, has made it a little difficult to obtain an accurate estimate of the mortality of Boston for the past year. As the only returns for the whole year are those of the registrar, these have been adopted, although not entirely accurate, the number of deaths registered by him for the last seven months of the year falling considerably short of that contained in the tables of the City Board of Health.

It appears from the returns of the city registrar that the number of deaths in Boston, in 1875, was 8,954, this exceeding by eleven hundred the number recorded in the previous year, an increase that may be, in part, attributed to the unusual length and severity of the winter, together with extraordinary epidemic influences during the latter part of the year. With a population that may be fairly estimated at 342,000, we have accordingly a death-rate of 26.18 in the thousand living, which is an increase of 2.59 per thousand over

* An attempt was made to compare the mortality of Boston during the past year with that of 1870, using for that purpose the census of 1875, and the "health-districts" into which the city had been subdivided by the late Dr. Derby. It was found, however, that the records of the city registrar did not contain information of sufficient exactness to make it advisable to publish a report based upon those returns.

For that part of the year during which the City Board of Health has preserved the records, statistics of great value have been preserved in a manner to make them accessible and thoroughly to be relied upon, for the first time in the history of Boston. It was hoped that the erroneous results reached in the paper on the mortality of Boston could be rectified, by means of comparison with the accurate records of the Board of Health. It was found, however, at a late day, that this was impossible within the limits of time allowed the writer, and the board regret to be compelled to withdraw a paper of value. The following report, originally prepared for the "Health of Towns," is commended by the board to that careful consideration which the reputation of the writer and its thorough research deserve. [ED.

that of 1874, and of 1.63 over the estimated mean death-rate of Boston. In the mortality tables of the City Board of Health for the seven months ending December 31, 1875, there are 79 more deaths recorded than appear in the returns of the registrar, which, added to those already quoted, give 9,033 as the whole reported mortality for the year, and a death-rate of 26.41; and for Boston, exclusive of the three recently annexed towns, 26.80 per thousand. By further excluding Roxbury and Dorchester, the death-rate rises to 28.32, which is not far from four per thousand above the mean death-rate for Boston previous to the annexation of these five towns.

The high death-rate that has characterized Boston for some years past, is largely due, as is shown in the recent report on the Sanitary Condition of Boston, to the excessive mortality among infants and children under five years of age, the mean death-rate under one far surpassing that of London, and almost equalling that of Liverpool, the most unhealthy of English cities. The year that has now closed is by no means an exceptional one in this respect, the death-rate of infants under one being somewhat above, although that of children under five falls a little below, the mean for the last four census years. The rate above five was also 2.7 per thousand above the mean for the same years, as also considerably above the mean decennial death-rate for London, as appears from the following table:—

Deaths in Boston per thousand living.	1855.	1865.	1870.	1875.	Mean of the four Census years.	London, mean of ten years—1851-1860.
Under 1,	-	265.5	276.9	275.8	272.7	-
Under 5,	99.4	99.2	97.2	86.8	95.6	78.0
Over 5,	14.7	15.6	15.5	18.8	16.1	16.6
At all ages,	25.4	23.6	24.3	26.1	24.8	23.7

The diseases that have been most prevalent are phthisis, pneumonia, and three diseases of the zymotic class,—scarlatina, diphtheria, and cholera infantum, to which may be added typhoid fever.

The mortality from phthisis, which was somewhat higher in the first and fourth quarters of the year, was less by seventeen than in the previous year; the percentage of deaths to the whole mortality falling to 14.90, or 3.86 to the thousand living, which is less than the mean death-rate from this disease for the last ten years, and pretty nearly corresponds with the mean decennial death-rate throughout the State, and marking a still further decline in the mortality from this disease, which has for some years been steadily decreasing. The

highest number of deaths (five per thousand) was in the twenty-third district, which comprises the northern slope of Beacon Hill, including the narrow, crowded streets at its base lying between West Boston and East Cambridge bridges. The northern side of this hill is inhabited largely by a colored population, and from its northerly exposure, and the nature of the soil, is cold and damp. From the analysis of the mortality statistics given in the report of the Commission on the Sanitary Condition of Boston, above referred to, it is shown that the high rate of mortality from phthisis is in a great measure due to the large Irish population, who show a marked proclivity to lung affections.

The deaths from pneumonia numbered 666, or more than 100 more than in 1874, and 7.43 per cent. of the whole mortality. This disease was especially fatal in the first quarter of the year, and its prevalence was probably due to the cold and prolonged winter; the average temperature for the first three months being 25.2, which is six degrees lower than during the same period in the previous year. The largest number of deaths was in district 23, where the death-rate was 2.3 per thousand. The lowest mortality was in district 28.

The large mortality from scarlatina and diphtheria was due to epidemic influences, not unaided by local causes, which will be alluded to below. The number of deaths from scarlatina was unusually large, amounting to 530, or 5.91 per cent. of the whole mortality. It was especially fatal in districts 20, 21, 35, 39 and 42, where filth and foul air have for years been allowed to do their legitimate work unmolested. The highest rate of mortality was in Brighton (district 45), where the death-rate was six in the thousand, not an improbable cause of which is suggested by one of our Brighton correspondents.

The deaths from diphtheria gradually increased from 49 in the first three months of the year to 234 in the last quarter, amounting to 418 for the whole year, and making 4.66 per cent. of the entire mortality, and a higher death-rate from this diesase than ever before here recorded. The highest mortality was in districts 38 and 45. No deaths were reported from district 26. Deaths from membraneous croup, which was more prevalent than usual, are not included in this estimate. The death-rate from the latter disease was 0.64 per thousand, or 2.45 per cent. of the whole mortality, being nearly double the mean for the previous ten years.

There were 680 deaths from cholera infantum, which is one more than the number recorded in 1874. These occurred mostly from June to October, inclusive, the highest weekly number being in the first week in August. The districts where it mostly prevailed

were those where it has been observed in previous years,—in over-crowded parts of the city, exposed to every insanitary condition. No case was reported from district 28.

The mortality from all the diarrhœal diseases taken together, including the last mentioned, was 999, which is not far from one-ninth of the whole mortality for the year.

The deaths from typhoid fever were 225, or 2.51 per cent. of the whole mortality, the number reported for the last half of the year being nearly double that of the first six months. Many of the cases are believed to have been imported from the country.

The mortality from the prevalent zymotic diseases, taken together, mainly due to scarlatina, diphtheria and the diarrhœal diseases, although not so high as in 1872, when the small-pox proved so fatal, was considerably above the decennial death-rate from 1865 to 1874, as will appear from the following table:—

Comparative Mortality from Zymotic Diseases in 1875.

DISEASES.		1875.	Mean for ten years.
CHOLERA INFANTUM,	Deaths per 1,000,	1.98	1.92
	Per cent. of mortality,	7.59	7.81
DIARRHŒAL DISEASES,	Deaths per 1,000,	0.93	1.03
	Per cent. of mortality,	3.56	4.19
SCARLATINA,	Deaths per 1,000,	1.55	0.93
	Per cent. of mortality,	5.91	3.85
DIPHTHERIA,	Deaths per 1,000,	1.22	0.21
	Per cent. of mortality,	4.66	0.86
MEASLES,	Deaths per 1,000,	0.18	0.13
	Per cent. of mortality,	0.70	0.52
WHOOPING-COUGH,	Deaths per 1,000,	0.08	0.20
	Per cent. of mortality,	0.32	0.82
TYPHOID FEVER,	Deaths per 1,000,	0.65	0.66
	Per cent. of mortality,	2.51	2.64

It is to a few diseases of this class, as has been shown by the able report above referred to, that is largely due the high death-rate of Boston for many years past. More than one-fourth part of the entire mortality the last year is attributable to these diseases; and, as they are believed to be especially promoted by insanitary conditions peculiar to certain localities, the testimony of physicians was requested as to how far they were able to trace the influence of these conditions in the cases that had fallen under their observation. The circular addressed to them contained the following questions:—

1. *Have diphtheria, scarlet fever, and typhoid fever been, in your*

experience, more prevalent or not during the past year than in the preceding year or years?

2. Have you had reason to regard these diseases as due to defective drainage or the presence of sewer-gases in the particular locality where they have appeared, or in its immediate vicinity?

3. Has cholera infantum been especially prevalent during the past summer, and what were the insanitary influences that seemed to you to promote it, or the three above-named diseases, whether in connection with locality, absence of sunlight, defective drainage, overcrowding, or insufficient water-supply, etc.?

4. Please give the localities, including street and number, where you have had cases of the above diseases, and where they have been most prevalent?

Of the physicians who replied to the above questions, there are many who were unable to perceive any connection between these diseases and the conditions referred to. By far the largest number, however, including many of wide experience, regarded their influence on diphtheria and typhoid fever as unquestionable. How far such influences affected the development of scarlet fever, there seems to be a more equal division of opinion. The fact that this disease not unfrequently occurred in places where no local cause could be assigned, may be readily explained by its communicability, and the constitutional proneness that exists in some individuals to zymotic diseases.

The following are quotations from the letters referred to, so far as our limits will allow:—

Diphtheria.—Dr. Bickford, of Charlestown (district 46), after mentioning the alarming prevalence of diphtheria, says, that "nearly every case that I have seen, has occurred in houses with defective drainage which, in this district, is fearfully bad in all houses which have been built from twenty to forty years, or more. They were laid on planks which have become decayed and broken away, allowing the drain to become clogged and the cellars to become filled with the fluids from sinks and water-closets."

Dr. Campbell, of East Boston, writes, that "the most malignant cases of diphtheria and scarlet fever occurred in localities where the drainage is imperfect, although not entirely confined to those places."

"I have, for a year past," says Dr. Cheever, "had recurrent (many times) cases of sore throat in a family of children, in Montgomery Street, which have wholly ceased since a defect in the soil-pipe was discovered and remedied." "I have just lost a patient (three months old) after five days' sickness of an obscure character, but pointing to some obstruction of the throat, and death from exhaustion, in East Chester Park, where sewer-gas is a daily nuisance in the wash-bowls,

and where, in summer, the Roxbury Canal, quite adjacent, has been unparalleled in vileness." Dr. Cheever also mentions "a case of slow and recurrent pneumonia in an infant who, during its sickness, was suddenly seized with vomiting its milk. The milk was prepared and kept in an open bowl, set into the water of the wash-bowl to keep it cool. Over this played a stream of sewer-gas from the overflow pipe—very perceptible; vomiting ceased when the food was removed, the overflow hole puttied up, and the bowl kept full of water."

Dr. Edes states that "the typhoid cases and the diphtheritic croup that he had seen, occurred in a badly drained district."

Dr. Hastings "has noticed more diphtheria and typhoid fever in parts of the city where drainage is imperfect."

Dr. Blood, of Charlestown (district 46), says: "In regard to diphtheria and typhoid fever, I believe the cause of all the cases that I have seen, without exception, to be defective drainage, the presence of sewer-gases being noticeable in or about the houses where the cases occurred." "I would not speak so strongly in regard to the cause of scarlet fever."

Dr. J. B. Ayer mentions cases as occurring at Portland Street (144), where the common sinks contained a great deal of refuse, and often emitted offensive odors. "In Myrtle Street (121), where the odors from the cesspools in the yard were very offensive, and the cellars so foul, that the tenants threatened to leave." "In Porcelain Place, where the cesspool occasionally sends up offensive odors; also offensive at high water."

Other cases are mentioned where no odors were noticeable, or where no inquiry was made as to their existence.

Dr. Nichols, of Roxbury, states that in his experience, "these diseases were decidedly more numerous, and the results less favorable in those districts imperfectly drained, or subject to the action of sewer-gases, or the emanations from the so-called midden-vaults."

"I have noticed," says Dr. Osgood, "for many years, that the above diseases have been much more severe in consequence of these gases, and in some cases, I believe, they were caused entirely by them."

Dr. Whittier attributes these diseases to "both defective drainage and the presence of sewer-gases." A paper was read by Dr. Whittier before the Society for Medical Observation, in October last, which gives four cases of this disease, where these influences were unmistakable in their effects.

The following extract is from a letter of Dr. Goss, of Roxbury:—

"I was called to see, some time in January, a child who was suffering from this disease, in Williams Street, where a child had

died of supposed diphtheria,—not a very severe case. Later in the year, the father had a severe attack of pneumonia, but recovered; still later, a child was taken with the same disease, and died. The mother, who was confined in September, had a tedious convalescence from pelvic cellulitis and other complications. This house is situated in what was formerly a marsh, or a part of a territory comprised in the Roxbury Flats. It is far below the level of the street, with no proper facilities for drainage, and water is standing, much of the time, under the house. I cannot affirm that the unfavorable location of the dwelling had anything to do with the cases of disease occurring therein, but am convinced that this, and many others in its vicinity, are built where habitations should not have been permitted until proper arrangements had been made for drainage."

Dr. C. D. Homans remarks that he has found no special cause for the few cases that he has seen, but "the drainage is defective everywhere."

Dr. Hyndman says: "I have had no reason to attribute the disease to either of the above-named causes." He subsequently states that his practice chiefly lies in the "*north part of the city.*"

Scarlet Fever.—Dr. J. B. Ayer mentions cases of this disease in Cusson Place (2), where the drains empty into the water-closets on each floor, and are often very offensive in summer. "In Cambridge Street (193), where the odors from the drains were very offensive through the summer and early part of the fall; often most intolerable. In Anderson Street and Bridge Court, where the water often rises in the cellar, but without odor."

Dr. Bush states that "the cases of this disease that he had seen occurred in crowded houses, in Middlesex Street, a part of the city that is considered well drained, so far as the street is concerned, but the pipes in the house were insufficient for the amount of work required of them, so that parts of the houses were in a foul condition."

Dr. Fisher mentions a house in Fabin Street where there were three cases and two deaths, and where "the surroundings are not as wholesome as they should be."

Dr. Morrill states that he has had cases of scarlet fever "which seemed to point directly to bad drainage as the only cause, this existing both in the exact locality of the disease, and in its immediate vicinity."

Dr. Street attributes this disease, as well as diphtheria, "to defective drainage, more than to any other cause beyond the control of the tenants."

Dr. Giddings, of Brighton, in allusion to the remarkable prevalence of scarlet fever in that district, where it has proved far more fatal than in any other portion of the city, says: "I am unable to

account satisfactorily for the outbreak of scarlet fever. We have no system of drainage, and cases have occurred with as much frequency in localities where elevation, slope, and soil would favor the disposition of extraneous matters, as in those where the surroundings would seem to favor and perpetuate the poison. There is one fact worthy of note, which may furnish an hypothesis by which we may account for the production of this disease. There is a low, flat piece of land (a sort of semi-meadow) lying along the south line of the Boston & Albany Railroad in Allston. During the fall of 1874 a large amount of compost from a slaughter-house was spread over this low land, and, for a time, for the distance of a mile or more, according to the direction of the wind, the most pungent and sickening and offensive odors prevailed. From that time to the present, scarlatina has prevailed, with an occasional case of diphtheria. I am forced to believe that, from this compost spread over this low land, the poison of scarlatina and diphtheria originated, and has been continued, by the diffusion of the poisonous gases and the principle of contagion."

Dr. Marion, of Brighton, states that he has seen scarlet fever in nearly every street in the district. "The epidemic began here in December, 1874, and raged through the winter months. Through the spring and summer there were only isolated cases. In September, 1875, it commenced again, and continued to increase till January, when it seemed to be at its height. Since then it has been gradually disappearing. In the winter of 1874–75 it was confined mostly to the more elevated portions of the town; during the past winter mostly to Allston; North Beacon Street might be considered the dividing line,—scarlet fever raging south of it in 1874–75, and north of it in 1875–76. During the year I attended one hundred and fourteen cases; of these sixty-three were of Irish parentage."

It will be noticed that the date of the outbreak of scarlet fever corresponds with that given by Dr. Giddings.

Typhoid Fever.—Dr. J. B. Ayer reports a case of typhoid fever in the rear of Spring Street (21), where the cesspool was under the privies, and where the odor in summer was strong enough to require the closing of the windows.

Dr. Belt, of South Boston, thinks that most cases "can be traced to defective drainage from houses to the street."

Dr. Blodgett thinks that the absence of any subterranean drain in a small, sunless court, was an important factor in the causation of the disease.

Dr. Minot mentions a case of this disease "in a boy eleven years old; one of obscure disease, with symptoms of nervous and physical prostration, lasting several months; and two or three cases of slight

indisposition, all occurring in the same family, which were supposed to be caused by sewer-gases escaping from a defect at the junction of the soil-pipe with the house-drain, discovered after the house was vacated."

Dr. Shattuck reports several cases "which appeared to be due to defective drainage."

Dr. Tarbell states that about one-fourth of the cases of typhoid fever that have come under his observation could be traced directly to some local origin; one-fourth only indirectly, and in the remaining half there could certainly be no such cause assigned.

Dr. Walker, of South Boston, mentions "two severe cases, which occurred among the attendants at the lunatic hospital, both of which were attributed to exposure to a foul drain while cleaning and repairing it."

Dr. J. C. Walker mentions "a case of this disease on Highland Park Avenue, where the location was high. The patient had not been into the country, and the disease seemed to be one arising from defective drainage. There was no sewer-drainage in the street."

Cholera Infantum. A very large proportion of the cases reported are believed to have been due to one or more of the causes mentioned in the following extracts from the letters of our correspondents:—

1. "Long-continued and excessive heat, acting on children who have been nourished on artificial food, in crowded and badly ventilated rooms, exposed to decaying animal and vegetable matters, bad drainage, putrefying excrement, and water contaminated with putrescent animal matter, especially soakage from privies.

2. "Offal thrown out of tenement-houses, being allowed to remain and decompose."

3. "Very hot weather in conjunction with unsuitable food and contaminated air. Absence of sunlight, defective drainage, and overcrowding, as also privies and swill-pails."

4. "Overcrowded, dark, badly drained houses."

5. "Overcrowding, absence of sunlight, improper food, improper clothing, want of cleanliness, bad sewerage and carelessness in the removal of refuse matter."

6. "Errors in diet (of 200 nursing-bottles carefully examined, but 20 were proved free from fungi)."

7. "A filthy house."

8. "Defective drainage, locality, overcrowding, in so far as this also implies filth; absence of sunlight."

9. "Overcrowding and improper feeding."

10. "Defective drainage, defects in water-closets, and stagnant water, as in open lots."

11. "Exhalations from filth-water."

12. "Exposure to the heat of a cooking-stove in rooms in the second and third story."

13. "Teething infants fed artificially, bad food, and overcrowding in streets and courts deficient in light and air."

14. "Bad drainage and improper food."

The localities where the above diseases principally prevailed are the same that have long been noted for high mortality rates. Those especially mentioned are districts 20, 21, 22, and 23, corresponding to the old wards 1, 2, 3, and part of 4; districts 29 and 30 to ward 7, which comprises the South Cove territory and parts of South Boston; and districts 35, 39, and 42, comprising wards 10, 13, and 15; also district 45, or Brighton, where scarlet fever proved so fatal. Many of these districts contain either a dense population, crowded into dark, narrow streets, or are characterized by *low, wet* or *ill-drained* land; and the inhabitants are largely composed of foreigners whose habits and proclivities especially predispose them to diseases of the zymotic class. The insanitary influence of new-made land is not apparent, as the highest death-rate reported (31 per thousand) was in district 21, which is upon the original soil, while the healthiest district, 28, is one, the larger part of which, a few years since, was covered by the waters of the Back Bay.

The above testimony is less important as showing a connection between certain insanitary conditions and a dangerous and fatal class of diseases, now generally recognized, than as pointing out the results of defective sanitation at our own doors, and the urgent necessity of such sanitary measures as in many foreign cities have proved so effectual. With a mortality as reported for the past year of 1,200 above the average mortality, that average itself being considerably above the normal death-rate of Boston, as shown by the report above referred to, and with all the facts and recommendations of two commissions before them, an unenviable responsibility rests upon the city authorities, should the warning pass unheeded.

The number of deaths in public institutions was 907, or not far from one-tenth of the whole mortality.

In connection with this subject, it would be amiss not to mention, however briefly, the recent reports of the two commissions just alluded to, one on the Sanitary Condition of Boston, and the other upon the Sewerage of Boston, appointed a year ago or more, under the auspices of the City Board of Health. The publication of these papers, drawn up with admirable care and ability, may be said to mark an era in the sanitary history of Boston, for it cannot be doubted that the suggestions contained in them will receive that attention which the character of the commissioners and the importance of the subject entitle them to.

The first-mentioned report includes a careful analysis of the mortality statistics, showing that the death-rate, which has been thought for some years past to be excessive, is due, in a great measure, to the large mortality among infants and children, as well as the large foreign element, especially Irish, in our population. Nearly two-thirds (58.4 per cent.) of the aggregate population, it is shown, are composed of foreigners and their offspring, of which large proportion two-thirds again (64-6 per cent.) are Irish, who are peculiarly prone to those diseases which act so large a part in swelling our mortality lists. Among these may be mentioned phthisis, pneumonia, Bright's disease, and certain zymotic diseases suggestive of defective sanitation, and appropriately termed "filth-diseases," the latter including cholera infantum, the diarrhœas, and typhoid fever. That portion of the second chapter treating upon the Influence of Nationality upon mortality is of especial interest, as is also the third chapter upon the "Nature and causes of the diseases which occasion our excessive mortality." In allusion to the sanitary needs of Boston, a more complete and accurate system of registration is recommended, and such sanitary measures as shall more effectually counteract the morbific causes that occasion one-fifth of all the deaths that take place, and which are shown to be removable. The most important of these measures is suggested in the following paragraph, which we quote at length:—

"The prevention of filth-infection, in its various forms, constitutes, without any doubt, the greatest and most urgent sanitary need of Boston. The attainment of this end imperatively calls for the adoption of energetic measures designed to prevent all possible contamination of our air, water and food, by the putrefying organic matters of all kinds which constitute 'filth.' Dirt has been defined as 'matter out of place'; so the filth, of which we speak, is but sewage out of place. When confined within its proper channels, and therein, constantly undergoing rapid removal, sewage is harmless, and does not deserve the opprobrious epithet which it incurs under opposite conditions; namely, when stagnating without, or even within, its channels; then poisonous vapors are generated and given off, which convey filth-infection in all its forms.

"By no other means can the purification of our city from filth be encompassed, than *by the rapid and continuous removal* from our midst of all refuse matters, such as constitute sewage, comprising solid and liquid excrements, foul household waters, etc., etc. Any reliance upon 'disinfectants,' as a means of public sanitation, would be but a delusion and a snare."

The appointment of the Commission on Sewerage was in compliance with a request of the City Board of Health. It had long been believed that there is a direct connection between decomposing matter and disease, and the experience of foreign cities had shown that, with an improved system of sewerage, sickness and mortality

had much diminished. It was thought that the time had come when Boston should have a system of drainage commensurate with the necessities of a great and growing city. "The evil of the present system of sewerage chiefly arises," says the report, "from additions being constantly made to the territory of the city, and from the sewers being necessarily extended through these low districts, and on flat grades, without a definite, comprehensive system." Many of them are insufficient for the work required, and others are so low that they cannot be emptied even at low tide. In other cases, there are no tide-gates, the sewers lie low, and the soil is incompletely drained, the cellars are often wet, and the sewer-gases are driven into the houses by the rise of the tide. It is also stated that "twenty millions of gallons of sewage are discharged daily at different points, completely skirting the city, and polluting the atmosphere throughout most of its length and breadth." The plan suggested by the commission is to carry the sewage far out into deep water, where its discharge will be remote from dwellings, by two enormous sewers extending from a point near Cottage Farm Station to the sea, on either side of the city; one to run in a south-easterly direction through the south part of Boston to Moon Island, and the other north-easterly through Cambridge, Charlestown, Chelsea, and Winthrop to its outlet at Point Shirley. It was proved, by experiment, that sewage discharged at these points would not return with the tide. With this system there is a constant and uninterrupted flow of the sewage from the time it enters the sewers until its discharge at the outlets.*

* See the map facing page 232; for the "health-districts," see the map facing page 512.

THE

SURFACE-DRAINAGE OF THE METROPOLITAN DISTRICT.

By C. W. FOLSOM, C. E.,
Of Cambridge.

SURFACE-DRAINAGE OF THE METROPOLITAN DISTRICT.

The districts in and around Boston which suffer from imperfect surface-drainage are of two classes: *salt-water* or *tide marshes*, and *fresh-water marshes*, swamps, or lowlands.

The *salt-water marshes* are of uniform character, composed of soft alluvial mud, with a surface-level of from ten to eleven feet above mean low water, rendering them always liable to be flowed at spring tides.*

Such salt-water or tidal marshes can, of course, only be drained by diking out the tide, and providing for the escape of any streams running down from the highlands by diverting them over the embankment, or allowing them to escape through self-acting tide-gates, or valves, at low water; in which way the ordinary water of rains over the marshes themselves would escape. In marshes of large area, pumping might be found necessary, as in Holland.

The *fresh-water marshes*, or lowlands, occur on almost all the brooks and rivers in this district, at all levels from their sources to their mouths, where they join the salt marshes (that is, in the vicinity of Boston, from 200 feet above the sea, downwards). In most instances they are of natural formation, but many of them are increased or aggravated by the flowing of mill-dams, as on the Charles and Neponset rivers.† Most of them are at such a level above tide as to render their drainage perfectly simple and generally easy, the fall of the streams below them being such as not to involve long or heavy cuttings for that purpose; but, owing to the fact that the land is held in small parcels, it would generally be impossible for the owner of a marsh to drain it except by entering on his neighbors' lands below him; for which reason, some general system, conducted, under legislative authority, by some central

* These range, in Boston harbor, from ten to twelve and a half feet above mean low water, and are even higher in exceptional storms. The height of the tide in the great storm of April, 1851, which carried away Minot's Ledge light-house, was about fifteen and one-half feet.

† See paper by Dr. George Derby, on "Mill-dams," and the evils caused by them, in the Report of the State Board of Health for 1872, pages 60–70.

power, would seem to be the only way in which drainage can be accomplished.

The evils of all these marshes, in a sanitary point of view, are chiefly as follows:—

1st. Houses cannot be built on them in their undrained condition without *wet cellars*, a well-recognized source of disease.

2d. The *air over them*, and for a considerable distance around, is *damp*, from excessive evaporation; a further cause of diseases such as consumption, rheumatism, neuralgia, etc.*

3d. A certain amount of *malaria* exists, from the decomposition of wet vegetable matter in warm weather, perhaps not generally sufficient in this latitude to create intermittent fever in those who are free from its seeds, but bringing it out in those who have contracted its taint in other States or countries, and probably affecting the general health of many in a similar way, but in a less marked form.

Much land that is not ordinarily called "marsh" is subject to the above evils. The immediate valleys of the streams may be of firm soil, and not marshy at ordinary seasons; but being scarcely or not at all above the level of the water in storms or spring freshets, it follows that all houses built there must be subject to wet cellars at those times. And so great is the difficulty of making an ordinary cellar perfectly water-tight, even with cement, with a constant head or pressure of water forcing its way in from the outside, that it is at best imperfect sanitation to build a house with the bottom of the cellar below the level of the water-table in the adjoining land.

The only cure for the evil of a marshy soil for building purposes that has been tried around Boston hitherto, has been by a simple raising of the ground by filling. The area of filled land in the metropolitan district has been roughly estimated at about 3,300 acres, or five square miles. Many districts † have been raised by the city, after they had become thickly inhabited, at an expense of several millions of dollars.

In case of fresh-water marshes, the proper cure lies in the lowering of the water-table in the soil by thorough drainage previous to building, and even previous to any filling that may be thought desirable. This drainage may ordinarily be effected by open ditches, protected in very loose soils by stoning the sides at bottom. If, owing to the thick crowding of houses, or the improvement of the

* See the article by Dr. H. I. Bowditch on Consumption, in the Report of the State Board of Health for 1873.

† For instance, in the vicinity of Church, Dover, Suffolk and Northampton streets in Boston, and of Washington, Sparks and Cowperthwaite streets in Cambridge.

land for garden or farm purposes, it becomes necessary to cover the water-courses, it may be effected by using dry stone culverts for the larger streams, often best supplemented by a filling of loose stone above the culvert, or by the common, unglazed, agricultural draining-tile for the valleys at the heads of streams. Tight brick or vitrified pipe-drains, if laid in cement, though excellent for carrying off the water when it has once got into the drain, cannot be well used for receiving and collecting the water from the soil. Common sewers, if properly built for their use as such, are not suitable for this purpose, unless for carrying off the water from loose drains above them; because, for use as sewers, they should be built as tight as possible; whereas, for the drainage of bogs and swamps, the drains should be open or loose in character for the whole length of the swamp, so that the surface-water may be quickly absorbed and carried away. The sewers, too, have generally to follow the lines of the streets, which are very rarely laid out lengthwise of the valleys of the streams, that being the place to which drains for surface-water should converge to be efficient.

It is impossible, in the limits of this Report, or without more detailed surveys, to indicate, except in the most general manner, the position of the places needing drainage. The whole districts of the "Back" and "South" bays, so called, in Boston, are familiar to every one. It is to be hoped that no portion of these lands in future filling will be left at the objectionable levels which have formerly prevailed; but it is worth considering whether more effort should not be made towards keeping the tide-water out of the subsoil after they are filled than has ever yet been done. It is to be remarked, that a large part of the lands which have been filled or raised in the suburbs, particularly in Cambridge and Somerville, are barely filled to high-water mark of spring tides. Before really good drainage or sewerage can be insured, it will be necessary to raise these lands very considerably higher.

The whole valley of "Stony Brook" in West Roxbury and Dorchester districts, with an area of water-shed, including small portions of Hyde Park and Brookline, of 8,000 acres, or 12½ square miles, can be drained by the city of Boston, under existing acts of the legislature.* On the upper portions of this stream are some of the worst swamps in the city of Boston. We would particularly mention as needing drainage on the waters of Stony Brook, the district in Dorchester bounded by Erie Avenue, Washington Street, Norfolk Street, and Blue Hill Avenue; and in West Roxbury, the district bounded by Morton, Back, Walk Hill, and Canterbury streets;

* See chapter 196 of Acts of 1874; chapter 220 of 1870; chapter 223 of 1868, etc., etc.

also, that bounded by Washington, Williams, and Forest Hills streets; also, that bounded by Centre and South streets and the Bussey Farm. Very many other places in Dorchester and West Roxbury require drainage, in the thickly settled as well as in the wilder portions. In Cambridge, Somerville, and Arlington there are considerable areas requiring drainage of the soil along the course of Alewife Brook.

Abstract of Areas of Upland and Lowland for Boston and Neighboring Towns, taken from the Report of the "Commissioners on Annexation," being City Document No. 105 of 1873.

	Area of Upland,—Acres.	Area of Marsh or Low Lands,—Acres.	Total Area, not including streets,—Acres.
Boston in 1873,	7,575	2,008	9,583
West Roxbury,	6,500	127	6,627
Brighton,	1,970	400	2,370
Charlestown,	340	198	538
Total Boston in 1875,	16,385	2,733	19,118
Cambridge,	2,415*	1,045*	2,983
Somerville,	2,312	50	2,362
Brookline,	3,500	500	4,000
Watertown,	2,312	55	2,367
Medford,	4,400	520	4,920
Winthrop,	697	185	882
Everett,	1,450	650	2,100
Revere,	2,100	1,300	3,400
Chelsea,	400	620	1,020
Total,	35,971†	7,658†	43,152

* The sum of these is 3,460 acres, which includes 477 acres of streets.
† The sum of these is 43,629, which includes 477 acres of streets.

In this paper there has been no attempt to treat the subject of surface-drainage in an exhaustive manner; the remarks here offered, necessarily confined within a narrow limit, are simply meant to be suggestive of the general importance of the matter, and of the need of attention to it by the cities and towns of the Commonwealth. The facts stated in this report are illustrated by the accompanying map.

THE HEALTH OF LOWELL.

1875.

By F. NICKERSON, M. D.,
Of Lowell, Mass.

THE HEALTH OF LOWELL.*

It is the general belief here, that the health of the city during the past year has been unusually good. The correctness of this belief is, in part, demonstrated by the following statistics taken from the reports of the city physician, and of St. John's Hospital.† It must be borne in mind that the population of Lowell has been increased by 1,100, the past year, through annexation:—

Deaths in Lowell.	1874.	1875.
Whole number of deaths,	1,184	1,017
Deaths from typhoid fever,	42	29
from scarlet fever,	100	19
from cholera infantum,	135	104
from consumption,	184	213
from pneumonia,	61	51
Cases Treated at St. John's Hospital.		
Whole number of cases treated,	280	217
cases of typhoid fever,	34	18
of consumption,	29	21
of pneumonia,	14	10
of rheumatism,	15	12

The numbers of deaths in the city from consumption, in 1872 and 1873, were 225 and 207, respectively.

The character of typhoid fever has been less severe than usual; and several physicians have observed, this fall, a diminished tendency to intestinal symptoms. In 1872, the number of deaths from

* This paper was originally prepared to be published under "Health of Towns"; but there are so many suggestions of importance as applying to other cities in the State, and as showing the need of establishing in them boards of health, that it is given here separately.

† The writer desires to express his indebtedness to many medical gentlemen, and especially to the city physician, for information embodied in this report.

this disease had reached 66. Water was introduced in January, 1873. Since then, the record has been as follows: 1873, 56 deaths; 1874, 42; 1875, 29. In St. John's Hospital there have been treated: 1872 (from April 1 to January 1), 68 cases; 1873 (the whole year), 39 cases; 1874 (the whole year), 34 cases; 1875 (the whole year), 21 cases.

The epidemic of scarlet fever may be said to have ended early in the year. The cases have been scattered, and generally mild.

There has been no small-pox.

Board of Health.

The Lowell Board of Health is composed of the mayor and one alderman; and, if the mayor declines to serve, of two aldermen and three councilmen. The work of this body is done by the city marshal, who, during the warmer season, employs one or more men to clean out alleys, and attend to such nuisances as may be complained of. No record of these operations has been kept the past year, an omission which I have felt very much, in my attempts to find out how far insanitary surroundings may have been connected with sickness. Since 1871, when the small-pox drove the municipal authorities, at last, into a state of desperate activity, this board has had no history, except in 1872. At this time, one of the members drew up a bill for the establishment of a superintendency of health, at an estimated annual cost of $1,500. The bill was rejected, on account of the expense. The income of the $27,000 just received by this city from licensed victuallers, would meet this estimate.

Diphtheria.

The Lowell mortuary record for croup and diphtheria, from 1846–76, is as follows:—

Year.	Diphtheria.	Croup.	Year.	Diphtheria.	Croup.
		19, 26, 41,	1866, . .	18	20
		19, 12, 18,	1867, . .	11	14
1846–1861, .	0	16, 29, 47,	1868, . .	3	14
		34, 33, 23,	1869, . .	7	23
		10, 24.	1870, . .	3	28
1861, . .	1	31	1871, . .	8	15
1862, . .	15	22	1872, . .	7	20
1863, . .	39	26	1873, . .	4	21
1864, . .	34	12	1874, . .	17	34
1865, . .	7	12	1875, . .	16	39

By these figures, it is observed: (1.) That, in some years which preceded 1861, the mortality from croup was far above the average. (2.) That no mention is made of diphtheria till 1861. These peculiarities are explained by the fact, that, several years ago, what we now call diphtheria, received the name of diphtheritic croup, which was registered croup. In the bills of mortality of Lowell at the present time, the term diphtheritic croup is not used at all. In 1863 and 1864, according to the list of deaths, and the testimony of some of the older physicians, there was an unusual amount of epidemic sore throat.

During the foregoing two years, there has been prevailing, more or less, in our city, an epidemic influence that has been productive of affections of the throat, which have been classified variously as tonsillitis, diphtheria, and croup. All the fatal disease of this class has been registered under the latter two heads. This epidemic influence, of which I have just spoken, has been much more marked since the last of September; all but four of the registered deaths of diphtheria, this year, took place in this period.

The first cases of diphtheria, which were brought to my notice, this year, occurred in the last of September, and in October, on Fayette Street, near the corner of Chestnut Street. Here, in a house on the moist, rich, sloping bank of the Concord, live two families, who have no association with each other. Family No. 1 occupies the ground floor on the street. In this family were two cases, one of which proved fatal, October 3. The odor from the vault is powerful, and peculiarly nauseating. Behind the house is a damp garden, which is sometimes overflowed by defective drains from neighboring dwellings. In the basement, farther down the slope, in a still damper situation, lives family No. 2, in which were three cases and one death, September 20. Under the sitting-room is an unventilated and unlighted cellar, four feet deep, where hens had been kept; a drain passes under the floor of the main sleeping-room. The smell of the vault which adjoins the room in which the deceased child lay sick, was so strong, at that time, that the doctor ordered the removal of the patient to another part of the house, Both these families use well-water. Farther down the slope, on the very edge of the river, reside an old man and his wife. The latter having attended the deceased child of family No. 2, was taken, on the day after its death, with symptoms of diphtheria. The overflown garden, above mentioned, adjoins this house. The vault is cleanly; city water is used. The sewage from these three tenements, as well as from those about to be noticed, passes first into a neighboring cesspool, and then into the river above its surface, where the odor is marked. On the opposite side of Fayette Street is a house

which was occupied, but has been vacated by families A and B. In 1872, there emptied into an open cesspool, two feet square, and situated in the cellar, ten sink-pipes. The cesspool overflowed, so that the cellar was constantly covered with sewage, the odor from which penetrated the house. Family A then consisted of five members, two of whom had typhoid fever, and one died. In family B, which numbered four, three had the same disease, and one died. After this, the number of sink-pipes was reduced to two. Family B vacated in due time. Family A remained, and was recruited to its original number by the birth of a child. The drain in the cellar was still a very perceptible nuisance, and the vaults were, at times, very offensive. The father died of typhoid fever last June, and two children died of diphtheria last October. Well-water was used here, in 1872; now, city water.

This part of Fayette Street has been for a long time notoriously unhealthy. The houses are crowded together on the side of a muddy hill. There is no proper sewer in the street. The vaults and sewage have been frequent sources of complaint. Intermural spaces, which are used as receptacles of all sorts of filth, are numerous, and the habits of the people are dirty.

Recently, in some courts a few rods below the locality which I have been just describing, there have been three or more deaths from diphtheria, and several persons are now sick with it. In a certain house there were three cases and one death. Here I found a dark alley, two feet wide, into which sewage was emptying and passing through the interstices of a crumbling stone wall, into a damp, ill-ventilated, and dark cellar.

The quarter known as Centralville is in the north-easterly part of the city. It is divided by Bridge Street into East and West Centralville. The former is situated mostly on high ground, and is healthy. The latter is on low ground, and is, for the most part, poorly drained and unhealthy, especially in the lowermost portion, whose general boundaries are as follows: On the north, a line drawn from Bridge Street through the line of West Fourth Street to West Street; on the south, the Merrimac; on the east, Bridge Street; on the west, West Street. Although a sewer has recently been built through River Street, most of this section drains into the meadow of which it is composed, and into a brooklet passing through it. Many houses are built directly over this stream, which is turbid in some places with the contents of vaults, etc. In the course of this stream have occurred at least twenty cases of sore throat, and three or four deaths, this fall.

The space bounded by Hildreth Street on the north, east by Jewett Street, south by West Sixth Street, and west by Coburn

Street, is a plateau which helps to drain the springy hills above Hildreth Street. It has been only recently settled; the houses are not crowded; the inhabitants are intelligent. The soil consists of loam, which rests either on sand or hard-pan. The drainage is all on the surface. This fall, on Coburn Street, in a house whose sink-drains emptied into the well, there was a fatal case of so-called typhoid fever, and in the same region where the sewage flows in streams about the houses and into the cellars, there was a case reported as croup, which recovered. On the corner of West Sixth and Coburn streets, were two cases of diphtheria, one of which resulted fatally October 22. The house stands on the verge of a meadow, twenty or twenty-five feet above it,—within a distance of twenty-five feet passes a surface drain-pipe which emitted bad odors previously to the deceased child's sickness. In another house on West Sixth Street, there were three cases. The first child, A, was taken sick October 28. She had been playing with one of the children who was afterwards taken sick in house No. 1. The mother of A had attended the funeral of one child in house No. 1 October 24. B was taken October 28; C, November 2; and D, November 8; no deaths.

In house No. 3, on Jewett Street, a little girl died of diphtheria November 11. This girl had stood over the death-bed of the child in house No. 1, and had associated with child B a good deal, even while the latter was sick.

In house No. 4, on Jewett Street, in rather a low situation, lives a family, who have had no association with the other families. The land on which the house stands is filled in with six inches of refuse from the city. The family in question occupy two rooms on the ground floor; viz., a sitting-room about 13 feet square, and an adjoining bedroom about 10 by 9. The ceilings of these rooms were completely covered with brown stains, which proceeded from a litter of pups kept by a filthy family above, so that the stench at times was very strong. The sink-pipe discharges its contents on the floor of the adjoining cellar. The sink-gutter from the tenement overhead passes over the roof of the piazza and opens over the sitting-room below, and deposits strongly smelling water, which has worn for itself a hollow, three feet from the well. The white paint of the house, in the vicinity of the gutter, is blackened with the sulphurous emanations. The solid excrements of the dogs, etc., were thrown under the window of the sleeping-room. The well is fifteen feet from the sewage in the cellar, and is covered with boards, on which it was the custom of the upper family to clean spittoons, etc. Some specimens of the water were drawn, and sent to Prof. Nichols for analysis. At the time the first specimen was taken, the depth of

the well was eleven feet eleven inches, and of the water five feet eleven inches. The family had noticed the disagreeable taste of the water for some time.* They had lived in the house but a few months before diphtheria appeared, and sickened four out of five persons, one of whom died November 12. The fifth was a babe of five months, at the breast. Of four women who attended the deceased child through its sickness of five days, one who lives in house No. 5, on Jewett Street, was taken with a slight sore throat on Tuesday, November 16. Another, who lives in house No. 6, on Jewett Street, was taken sick, and two children followed; no deaths. A third woman, who lives half a mile distant, escaped; but her daughter was attacked on Monday, November 15, with fever, sore throat, swollen tonsils, and white deposits on the latter. The fourth woman, who lives a mile distant, on a hill in a perfectly healthy locality, where there had been no cases of sore throat, was seized on Wednesday, November 17, with diphtheria; a girl four years old on Monday, November 22; a boy of seventeen years on Tuesday the 23d; husband had sore throat on Sunday the 28th, and also a sister on December 5.

The following table will give some facts as to age, nativity, etc. The numbers included in the braces belong to one family. In addition to the cases thus tabulated, I have learned of the following: In an Irish family of four children, whose surroundings I have not examined, one child died unexpectedly after a week of convalescence. In another family,—Americans, in a healthy region,—an adult died October 30; four children, whose ages range from two to nine, were sick, and recovered. There had been for some time a very offensive discharge of sewage from a leak in the drains in the cellar, which connect with the main sewer. In 1874, a woman in Dracut had the disease (some days, time not precisely ascertained), after inhaling the fumes of an obstructed sewer, which she describes as powerful and nauseating; she recovered. No other cases in the neighborhood. No history of exposure.

* For the analysis of the water of this well, see page 270.

Number.	Sex.		Age.	Parentage.				Attack.		Date.	Duration.	Recovery.	Death.	City Water.	Well Water.	Remarks.
	Males.	Females.		American.	English.	Scotch.	Irish.	Mild.	Severe.							
1	1	-	7	1	-	-	-	-	1	Nov., 74,	-	1	-	-	1	Location very damp—a meadow; water one foot deep in cellar; kitchen adjoins cellar; drainage, surface, and bad.
2	-	1	4	1	-	-	-	-	1	Nov., '74,	-	-	1	-	1	
3	1	-	6	-	1	-	-	-	1	Sept., .	3 weeks,	1	-	-	1	Filthy vault; location damp; drainage not good; girl taken a week after the boy; soil, rich loam.
4	-	1	2	-	1	-	-	-	1	Sept., .	12 days, .	-	1	-	1	
5	1	-	7	-	-	-	1	-	1	Sept. and Oct.	2 weeks,	-	1	-	1	Filthy vault; soil, rich loam; location, on the bank of Concord; drains into river.
6	1	-	9	-	-	-	1	1	-	Sept. and Oct.	-	1	-	-	1	
7	1	-	8	-	1	-	-	-	1	Sept. and Oct.	11 days, .	-	1	-	1	Well fifteen feet from privy; private drain.
8	1	-	3	-	1	-	-	-	1	Sept. and Oct.	1 week, .	-	1	1	-	Cellar damp; drainage bad, also vaults; soil loamy.
9	1	-	7*	-	1	-	-	-	1	Oct., .	2 days, .	-	1	1	-	
10	-	1	1	1	-	-	-	-	1	Oct., .	4 days, .	-	1	1	-	Drainage, surface; soil, a loam upon hard-pan, just above a filthy meadow.
11	-	1	6	1	-	-	-	1	-	Oct., .	-	1	-	1	-	
12	1	-	10	1	-	-	-	-	1	Nov., .	-	1	-	1	-	No public sewer; location high; soil rocky.
13	-	1	40†	1	-	-	-	1	-	Nov., .	-	1	-	1	-	
14	-	1	40†	‡	-	-	-	1	-	Nov., .	-	1	-	1	-	

* Months. † About. ‡ German.

Number.	Sex.		Age.	Parentage.				Attack.		Date.	Duration.	Recovery.	Death.	City Water.	Well-Water.	Remarks.
	Males.	Females.		American.	English.	Scotch.	Irish.	Mild.	Severe.							
15	-	1	8	1	-	-	-	1	-	Oct. and Nov.	Few days,	1	-	1	-	Drainage, surface; location low, just above a meadow used for drainage; suspicion of contagion in one case. (15–17)
16	1	-	6	1	-	-	-	-	1	Nov., .	5 days, .	1	-	1	-	
17	-	1	12	1	-	-	-	-	1	Nov., .	1 week, .	1	-	1	-	
18	-	1	5	-	-	1	-	-	1	Nov., .	4 days, .	-	1	-	1	Drainage, surface; location low; soil, loam on sand; probable contagion.
19	-	1	4	1	-	-	-	-	1	Nov., .	5 days, .	-	1	-	1	Drainage bad; water bad; location low and damp; cellars damp. (19–22)
20	-	1	2	1	-	-	-	-	1	Nov., .	1 week, .	1	-	-	1	
21	-	1	25*	1	-	-	-	1	-	Nov., .	-	1	-	-	1	
22	1	-	27*	1	-	-	-	1	-	Nov., .	-	1	-	-	1	
23	-	1	45*	1	-	-	-	1	-	Nov., .	-	1	-	-	1	A high hill in the country; quite evident contagion; surroundings all healthy. (23–27)
24	-	1	4	1	-	-	-	-	1	Nov., .	5 days, .	1	-	-	1	
25	1	-	17	1	-	-	-	1	-	Nov., .	-	1	-	-	1	
26	1	-	45*	1	-	-	-	1	-	Nov., .	3 days, .	1	-	-	1	
27	-	1	50*	1	-	-	-	1	-	Nov., .	-	1	-	-	1	
28	-	1	55*	1	-	-	-	-	1	Nov., .	5 or 6 d'ys,	1	-	1	-	Probable contagion; location damp.

29	-	1	6	-	1	-	-	-	1	Dec., .	5 days, .	-	1	1	-	Location just above a filthy meadow; probable contagion from child.
30	-	1	22	-	1	-	-	1	-	Dec., .	-	1	-	1	-	
31	1	-	6	1	-	-	-	-	1	Dec., .	4 days, .	-	1	1	-	Very damp; drainage and vault bad; cellar with half a foot of water on floor.
32	-	1	12	1	-	-	-	1	-	Dec., .	-	1	-	1	-	
33	1	-	9	-	-	1	-	1	-	Dec., .	-	1	-	-	1	Location low and damp; well two feet from drain; no sewer; soil, a rich loam.
34	1	-	7	-	-	1	-	1	-	Dec., .	1 week, .	1	-	-	1	
35	1	-	5	-	-	1	-	-	1	Dec., .	1 week, .	-	1	-	1	
36	-	1	9	1	-	-	-	-	1	Dec., .	5 days, .	-	1	-	1	Low and damp; two drains pass directly by well; cellar dark and ill-ventilated; no sewer.
37	-	1	4	1	-	-	-	-	1	Dec., .	1 week, .	1	-	-	1	
38	1	-	6	-	-	-	1	-	1	Dec., .	1 week, .	-	1	1	-	Crowded; habits filthy; open cesspool; filthy court.
39	1	-	1	-	-	-	1	-	1	Dec., .	2 days, .	-	1	1	-	
40	1	-	4	-	-	-	1	-	1	Dec., .	2 days, .	-	1	1	-	Low and damp, near filthy brook; habits filthy.
41	1	-	2	-	-	-	1	1	-	Dec., .	-	1	-	1	-	
42	1	-	6	-	-	-	1	-	1	Dec., .	1 week, .	1	-	1	-	
43	-	1	30	-	-	-	1	1	-	Dec., .	1 week, .	1	-	1	-	
44	1	-	7	-	-	-	1	1	-	Dec., .	2 days, .	1	-	1	-	
45	-	1	8	-	-	-	1	-	1	Dec., .	11 days, .	-	1	1	-	Vaults bad; location damp; soil, new rich loam; drainage filthy.
46	-	1	10	-	-	-	1	1	-	Dec., .	-	1	-	1	-	
Total, .	22	24	-	23	7	4	11	19	27	-	-	29	17	24	22	

* About.

The epidemic of diphtheria, this fall, though mostly localized, has spread itself throughout the city; but has been thus far, at least where deaths have occurred, almost wholly confined to insanitary dwellings. Six of the fatal cases occurred in the Fayette Street locality, and six in Centralville. There have also been two deaths from supposed croup; one in each of these regions.

The following laws have been observed in this epidemic.

1. The disease is contagious.

2. The period of incubation, in the few instances where it could be ascertained with any approach to certainty, was about one week.

3. The attack usually comes on suddenly, with severe constitutional symptoms; death takes place by obstruction to respiration or by prostration. Convalescence is usually rather slow.

4. There have been no persons older than fifty-five in the families where cases have been observed. In four different families where more than one sickness took place, there were four infants of seven, nine, five, and five months; of these, the first, who had been weaned from the breast a month before it was seized, died; the others, who were confined to breast milk, had no symptoms of diphtheria.

5. As in epidemics of typhoid fever and cholera we have a great many "febriculæ" and diarrhœa respectively, so in this epidemic we have had numerous "sore throats," severe and mild.

6. The disease was usually less severe in adults than in children. The average age of decedents was four years and eight months. The maximum age was nine years, the minimum seven months.

7. The records of wind, temperature, and weather give no light as to causation.

The foregoing observations, if they do not point us to the specific cause, sufficiently indicate the direction in which we are to look for the common source and maintenance of this as well as other epidemics that have recently visited our city. In 1871, small-pox found most of its victims among those most neglectful of sanitary laws. In 1872, typhoid fever did its heaviest work in a region flooded by sewage. In 1873, cerebro-spinal meningitis was most rife in the crowded parts of the city. In the same year, scarlet fever was the most virulent in nearly the same region where the typhoid of 1872 had prevailed; thence it swept the city in 1874; and now, in 1875, diphtheria is added to the catalogue of our crimes against the laws of health.

Lowell takes the second place on the list of the most populous cities in this State; last year she occupied nearly the same numerical position in her death-rate.

HEALTH OF TOWNS.

HEALTH OF TOWNS.

Replies to our circulars have been received from all the cities and from 185 of the 322 towns in the State.

Boston is the only one of the cities which has a board of health other than the officers of the city government. In regard to the rest, our correspondents generally speak of the urgent need of such independent boards. It may fairly be said of the substitutes for them, as was stated in the fourth report of the Board (p. 515): "No doubt can be left on the mind of any one who examines these letters [of our correspondents] that the boards of health of most of the cities and towns of Massachusetts have no idea of the responsibility which belongs to their office." It should be said, moreover, that the selectmen of our towns and the executive officers of our cities have not the time to attend to the duties of health officers, not to mention the fact that they are not especially fitted by education for such work.

In the 185 towns, our correspondents state that the selectmen act as boards of health in 80; that there are no boards in 70 (which is probably equivalent to saying that the selectmen act as such); in 26 it is reported that there are special boards of health; from 9 no report is made. In some of the towns, the selectmen unquestionably do perform and are reported by our correspondents as performing their duties to the eminent satisfaction of all parties. Such cases are the exception, however, and not the rule.

One board of health elected in one of the towns neglected to qualify; in another, an elected board of health is reported as not attending to their duties and as deserving of censure.

We quote from a few of the replies to our circulars, as follows:—

"There is an advisory board consisting of one physician from each ward (five in number). This board gives advice from time to time, which advice is rarely heeded."

"The selectmen of the town constitute our only board of health, and in that capacity have been very quiet."

"There is no board of health. The selectmen act in that capacity when it is unavoidable, but practically almost nothing is done."

"A law should be enacted requiring that there be at least one physician on the board of health of every town and city in the State. The reasons for this are self-evident."

"The board of health are the selectmen. There is no physician a member of that body. These functionaries (the selectmen) give but little heed, as a general thing, to the recommendations of physicians, however judicious, unless such recommendations can be carried out with little or no expense to the town. An intelligent and efficient board of health is greatly to be desired."

"The selectmen of the town constitute a board of health. The fear of losing votes will always prevent a board so constituted from doing the whole of its duty."

"The selectmen of the town are the only authorized board; which amounts to nothing."

"Since the small-pox epidemic, the board of health has been discontinued, and their duties assumed by the selectmen. The expense was assigned as the reason."

In the winter and spring of 1875, acute pulmonary diseases are quite generally reported as having been more prevalent and fatal than usual.

The diarrhœal diseases and enteric fever are thought, by our correspondents, for the vast majority of the cities and towns, to have been less prevalent than usual, or at least not more so, during the year.

Fatal small-pox prevailed in Russell, a small town of 600 inhabitants.

Epidemic influenza was observed quite largely throughout the State, in many cases coincident with the epizoötic among horses.

Scarlet fever has been more wide-spread than usual, and more fatal in its results. The chief elements in its spread are evidently contagion and infection; but the evidence of our correspondents, as in former years, goes to show that it assumes especial virulence in the presence of putrefying organic matter; in damp, sunless localities; where the poison is concentrated by overcrowding or other causes; and where the vitality is lowered and the power of resisting disease in the individual is in any way diminished.

Diphtheria has prevailed to a considerable extent throughout the State; in the majority of cases, mild in character, and

occurring only sporadically. The replies of our correspondents are quite full on this point, and we quote from them rather largely.

Undoubtedly, erroneous diagnoses have often been made; and worse than useless alarm has often been caused from confounding other diseases with diphtheria. Many of our correspondents mention this fact, and comment on it somewhat severely. Of course, it is for the interest of the charlatan to make it appear that every mild disease is a dangerous one, so as to exaggerate the importance of his alleged "cures"; and he has, evidently, made free use of the popular fear of diphtheria, the past year, to serve his purpose.

In England, diphtheria is quite universally classed among the so-called "filth-diseases"—a name now enjoying quite a fashionable prominence. Many writers attribute its increase in that country, of late years, to the more general introduction of sewers during the same time, and have no hesitation in assigning sewer-gases as its chief cause. This general opinion is well expressed in the following extract from a report on the health of Tottenham in 1875:—

"There were twelve deaths from diphtheria,—a great many too many, though four fewer than last year. This, too, is a filth-disease, and is believed to arise in almost every case from foul air within houses themselves. There has been scarcely a case of diphtheria in Tottenham, in a house where some serious defect in the house-drains was not discovered. That diphtheria nearly always arises from want of pure air within the house itself, is also shown by the fact that out of the forty-seven deaths from diphtheria in Tottenham during the last four years, only seven occurred during the five months, May—September, when, of course, windows and doors are kept open. On the other hand, during the coldest three months in the year, December, January and February, when houses get but little fresh air, and when also, owing to the much higher temperature within doors, sewer-gas forces its way in through unventilated drains and defective traps, there were twenty-five deaths, as compared with only twenty-two during the remaining nine months of the four years."

This statement is not fully borne out by experience in Massachusetts during the past year. The disease has not, as a rule, prevailed during the warm months; but in those towns where its fatality has been the heaviest, there have been no water-closets used, and the closing of the windows could not expose the occupants of the houses to any greater

concentration of sewer-gases. Our correspondents place the element of contagion very high in the causation of diphtheria. From the 204 reports, there are many cases given which give strong support to this theory, although it cannot be said to be true to the same degree that it is of small-pox, measles, and scarlet fever.

That so many cases were exposed without contracting the disease, would apparently imply that something more is needed than the mere exposure to the poison. In one town, for instance, two very severe cases, both fatal, were imported from Canada; and although no care was taken to prevent such a result, there was no spread of the disease, and not another case occurred in that town during the year. One of our correspondents observed that the disease had been communicated in a violent form to those who "laid out" bodies of persons having died of diphtheria.

From Pittsfield, Royalston, and Lanesborough, especially, the evidence is strong that the disease is also infectious.

Exposure to cold and damp is given as at least an important predisposing cause. In this connection, it is proper to speak of the privies of many of our public schools and dwelling-houses in terms of the strongest reprobation.

Bad drainage is thought by most of our correspondents to be associated with diphtheria in the immense majority of cases, or that its greatest severity is reached in badly-drained localities; *i. e.*, where the soil is not or has not been properly dried, an evil which may obtain on high as well as on low land. This, however, is not thought sufficient of itself alone. Many low-lying and wet towns, where drainage of the soil is very imperfect, even where, too, a water-supply has been introduced without sewers for its proper removal, have been rarely visited with the disease, and then only lightly. We have no means, however, of knowing what the result might be if such towns were exposed to the virus of the disease in a concentrated form.

Filth, although not so evidently connected with diphtheria as with typhoid fever, diarrhœa, and dysentery, plays an important part in its causation, especially when associated with dampness. In some of the towns, the contamination of drinking-water with filth has appeared to be at least partially at

fault; in a few cases, the evidence is quite strong as to its being, if no more, a cause of unusual severity in symptoms or of more extended prevalence. In Holyoke, the proximity of water-closets to sleeping-apartments was suspected, as being the chief insanitary condition observed in connection with the disease.

In a certain proportion of cases, the conditions were supposed to be wholly atmospheric.

Some of our correspondents, finding no other constant cause, are inclined to attribute the prevalence of diphtheria very largely to individual predisposition. A few again find no difference in age, sex, locality, etc., and are utterly at a loss to account for their cases. In Worcester and Millbury, where the Blackstone River is fouled so extensively by sewage from houses and manufactories, but where the soil is for the most part dry, very few cases occurred. In Boston, Woburn, Lynn, and Salem, however, where the sewage is offensive and the soil wet, the disease was quite prevalent. In New Bedford, of a very severe epidemic, few cases occurred where the sewers had been built and in use. Of thirty-eight deaths in that city, eleven occurred among the pupils of one school, where there was no ventilation except from opening the windows, and where there were two privies just outside the walls of the building. Both of these causes of exposure to young children *indicate a recklessness or ignorance in regard to their health which can hardly be called less than criminal.*

Diphtheria has been unusually prevalent in Wakefield; but our correspondent, a careful observer, finds no explanation for it. Many of his cases occurred in damp localities. On the Merrimack River, Lowell, Lawrence, and Haverhill suffered considerably. From Boston as a centre, the disease is to be traced along the Charles and Mystic rivers to some distance, and lying largely between the two.

In the northern and north-western parts of Essex and Middlesex counties, the disease was, in most cases, mild, or not largely prevalent.

From New Bedford, where there was a severe epidemic a year ago, the disease can be apparently followed northward to Taunton and Walpole, and easterly through the southern towns of Plymouth County, to the western ones of Barnsta-

ble. In Yarmouth there was a severe epidemic, but quite local. Beyond that town, the disease is reported as not occurring, or very rare. The soil on the Cape is gravelly and dry.

In Norfolk and Worcester counties, the epidemic for the most part fell lightly, the cases having been generally sporadic. In Westborough and Leicester, diphtheria was prevalent. In the northern part of Royalston, a small, unsewered town, the mortality was excessive, twelve deaths having occurred out of twenty cases, every one of which was thought by our correspondent to be traceable to contagion; the adjoining towns of Winchendon, Phillipston, Athol, Orange, and Warwick escaped entirely, or nearly so.

In the lower part of the Connecticut Valley, West Springfield alone suffered severely, although cases occurred in Longmeadow, Springfield, Holyoke, Westfield (prevalent), and Easthampton. Northampton escaped almost entirely, while a number of severe cases occurred at Hadley, across the river.

The disease prevailed with the greatest malignancy in the northern and western parts of the State, where the population is as largely American as anywhere, the land high but often moist, and drainage almost entirely left to nature. In Williamstown and Adams, the epidemic fell heavily. Following down the valley of the Deerfield River, Florida, Heath, Charlemont, Leyden, Shelburne, Conway, Greenfield, Deerfield, Bernardston, and, east of the Connecticut River, Montague and Northfield, suffered severely. Rowe, Hawley, and Buckland escaped with less prevalence and fatality. In some of these towns, the epidemic was nearly over by the beginning of 1875.

In Berkshire County, thirteen out of the fourteen towns heard from report cases of diphtheria; except in its northern section, however, the disease does not appear to have been very prevalent.

In those towns throughout the State where especial prevalence or severity of the disease has been marked, there are no sewers; in only a few of them are there any water-closets; and the gases from decomposing organic matter have no opportunity to reach the insides of the houses, unless, possibly, from vegetables stored in the cellars. That is to say, the

disease has been for the most part one of the unsewered towns; in the cities where there are sewers, it has been most prevalent, or entirely so, in those parts which are badly drained or have no sewers. An exception must be mentioned in this respect, however, with regard to a few cases in the best houses in Holyoke.

The mortality in some of these towns was excessive; namely, from sixteen to fifty, or even seventy-five, per cent. of the cases attacked. In Conway, where there is a large Irish population, the Americans were almost the only ones attacked; and one-tenth of the native population suffered from the disease, of whom thirty per cent. died. The foreign population escaped almost entirely, although living in a condition of filth not seen in the houses of their less fortunate fellow-townsmen.

In Greenfield, especially, the disease was chiefly met in very low and wet localities; in Florida and Adams, it was most prevalent on high land,* and largely among foreigners.

One fact is impressed on us with great force,—that the disease is primarily connected with decidedly insanitary conditions; but that, after a certain degree of concentration of the poison has been reached among those living under bad hygienic circumstances, the best attention to sanitary law will not in all cases protect the more fortunate part of the community who reside in the best parts of towns and cities.

The conclusions at which we have arrived from the facts reported to us by our correspondents, are as follows:—

I. That diphtheria is contagious, and may be under certain circumstances highly so.

II. That it is also infectious, although not to so great a degree as scarlet fever, measles, and small-pox.

III. That, where other circumstances assist, its spread is promoted by dampness or moisture of soil, whether naturally existing or produced, especially with a tough, impervious subsoil.

IV. That the special connection between this disease and

* The soil is quite shallow, overlying rock. Our correspondent thinks that diphtheria prevailed more extensively on the western than on the eastern slope of the Hoosac range.

filth is not so clearly made out; although such a condition would undoubtedly aggravate the bad effects of moisture alone. The subjects of contamination of well-water by human filth, and of the air of sleeping-apartments by sewer-gases, as predisposing causes of the disease, deserve more careful study in the future; our returns do not at present give us sufficient data for the expression of a positive opinion. Some of our correspondents suspected the introduction into the system through drinking-water of some septic influence which gave rise to the disease.

V. That exposure to dampness and cold, especially among children and those otherwise predisposed to the disease, tends to induce diphtheria.

VI. That Americans and foreigners in Massachusetts have been about equally subject to the disease, other matters than that of nationality being equal.

VII. That individual or family proclivity, age, and depression of the vital powers from any cause whatever are important factors in inducing this disease (as well as others) more rapidly and in a more fatal form, when other causes are also in some degree present.

VIII. That there is also some atmospheric condition, of which little is now known, the presence of which, even if not necessary, is at least important in the causation of diphtheria.

Extracts from Letters received from our Correspondents in regard to Diphtheria.

Amesbury.—I have known of no cases during the past year where the sanitary conditions of the houses, etc., were at fault. The worst cases previously in my practice occurred in families well off, of good judgment, intending to take the very best care of their children. The constitutions of the children were at fault,—the mother of one dying of consumption soon after the child's birth; another never having been a "rugged" boy; others belonged to a family in which the children all die young.

Amherst.—Two of these cases were in perfectly healthy localities. The Irish family in which were the other four cases live in a neat, small house, nearly new, on a dry, sandy, and gravelly knoll, one hundred rods from any other dwelling, cellar dry enough to keep shavings, the whole house and surroundings neat and cleanly. Only two possible causes occur to me: one, the fact that the family of six slept in one small bedroom, 6 by 8 feet; and the other, that within fifty rods runs a small stream that, before it passes the house, drains a region of Irish and American tenements, taking the wash from the same, and opposite the house opening out into a small pond.

Arlington.—I have seen very little diphtheria, though the sore throats have taken on a diphtheritic type; the cases have been sporadic,—some among the best hygienic circumstances, and some in the most unfavorable.

Ashburnham.—There have been numerous cases of tonsillitis, with copious patches of lymph on tonsils, palate, etc., but none of diphtheria.

Ashby.—Diphtheria has never prevailed in this town as an epidemic, or at least not for the past ten years, although every year brings a few cases.

Attleborough.—Diphtheria prevails here in all varieties of soil and hygienic condition, severest among children of lymphatic temperament.

Barnstable.—So far as I know, there have been but two fatal cases during the year; they occurred within about two hundred rods of a slaughter-house, and the question arose as to the probable influence of the same,—*doubtful.* The rest of the family had diphtheritic sore throat.

Bedford.—There has been no case of decided diphtheritic inflammation; but the tendency to inflammation of the throat, with constitutional symptoms in excess of local lesion, has been somewhat prominent. I have not been able to connect these phenomena with any local cause.

Belchertown.—No case of diphtheria has occurred for the last five years. About sixteen years ago, we had a large number, and several fatal cases; and five years ago I had seven cases in one family—two fatal; but it did not extend from this house, and I have had no cases since.

Berkley.—It seems to me to prevail more in wet locations. I do not know that any other circumstances have much effect. I might say that there are several locations in Berkley where I think the water is not good. . . . A school-house and privy have been very recently built; the school-house has been used only two terms—the privy very little used. The situation of the privy is on the side of a hill, near the base, about eight feet higher than the spring (used for drinking), and eight feet east of it, the water-courses running in the direction from the privy to the spring.

Beverly.—The following is an account of eight cases of diphtheria in a family of ten, which occurred in my practice in Beverly, last July, and which appeared to be due to a specific origin. The family live in a one and a half story house, eighteen feet square, containing three small rooms on each floor. There is no cellar, the house resting upon the lower border of a rocky ledge, which is mostly bare, cut by numerous deep fissures, and only in small spots covered with a few inches of soil. The ledge rises with a sharp inclination from the eastern side of the house for about fourteen feet, where there is a small level spot, upon which was located, until the second week in June, a wooden privy, resting upon a brick wall. The vault had a depth of a foot and a half below the surface-soil (which was deeper here than upon the slope), the bottom being the ledge, which dipped slightly in the direction of the house. The occupant of the house said that he was particular to have the vault cleaned out twice a year, and also that he occasionally threw down ashes and dry earth. Early in June, the house covering the vault was moved from its position on the south-east corner to the south-west corner of the yard, at the request of a gentleman who found the privy to be in too close prox-

imity to his own new house, then being built upon a higher part of the ledge, about forty feet away. The new location of the privy is about the same distance from the house as the old one. The vault was uncovered only for a few hours, the contents were not removed, and the hole was filled with earth. Early in July, I was called to visit a member of the family. The patient, an infant, always had been a sickly child, had had convulsions at various times, a similar attack being the occasion of my attendance.

While in the house, I learned that four of the children were troubled with sore throat, the first case of which had appeared about three weeks after the removal of the privy, the other three following with intervals of only a few days. As the symptoms were all slight, the parents were not alarmed, but treated them themselves. July 28th, I was called to attend one of the sons, ten years old, who had been sick with "diphtheritic" sore throat for four days, but not so severely as to alarm the parents until the morning of the 28th. The child sank rapidly, and died early in the morning of the 29th. In about ten days, as I am informed by the mother, two more children and the father were sick with sore throat, but not seriously. In all, there were eight members of a family of ten, who had diphtheria in a mild form (with the exception of the one who died), in a period extending from the last week in June to the second week in August. There were no other cases of diphtheria in the neighborhood at the time, nor had there been any for five months, and I could learn of no other cases in town; and, although the house is in a thickly populated street, no cases followed the outbreak in that house. The question arose, Did these cases owe their origin to local miasm? With the view of solving this question, I investigated the premises carefully, with the following result: I could discover no unpleasant smell in any part of the house; I could find nothing in the fissures of the rock indicating escape of matter from the closed vault; nor could I learn that there had been any appearance of leakage, either before or after the vault was filled in, though it seems possible that the filling in of the unemptied hole may have forced some of the contents through the slight covering of earth, in which case it would run down toward the house. In a small room, opening directly from the kitchen, was the sink, the drain-pipe of which opened within two or three feet of the north side of the house. The ground near the outlet of the sink was wet, but I could not discover whether there was any leakage directly under the floor, as it will be remembered that there is no cellar. The tenant stated that dish-water sometimes was thrown into the sink; but usually the slops of all kinds were thrown into the vault. I think that the condition of the privy and the sink combined was sufficient to account for the outbreak. The drainage from the privy was directly toward the house; the house has no cellar, and any leakage from the sink must accumulate either under or in close proximity to the house, for it could not flow through the ledge on which the house rested; if the drainage from the vault mingled with the sink-water, it multiplied the possibilities of miasm; the effluvia from the privy must have contaminated the air in and about a house only fourteen feet distant; the season of the year is the most favorable for rapid decomposition of organic material. These are sufficient reasons, it seems to me, for attributing the first cases, at any rate, to local miasmatic causes. Were the other cases the result of personal contagion, or due to the same cause? Had the fifth child taken the disease from the other children, it is probable that, taking into account the number of occupants of such a small house, the manifestation of symptoms would not have been delayed from the 8th to the 24th of the

month; and similarly with the last cases, which, I am informed, did not appear for ten days after the fatal issue of the fifth case. If my supposition as to the origin of these cases is correct, it simply shows that the signs of defective drainage may not be striking enough to attract attention until we are led to investigate the causes of an apparently unaccountable outbreak of zymotic disease.

Blackstone.—A few years ago, two children were brought here from Canada sick with the disease, and died of it in a few days. No others had it in town at that time or subsequently.

Blandford.—There has been no diphtheria during the past year, and very little since 1863. Then it prevailed as an epidemic, with much severity. The localities where it occurred are high and dry, with no known exciting cause.

Brewster.—In July, diphtheria broke out in a family consisting of a mother and four children, the father being absent on a fishing voyage. The disease was contracted, undoubtedly, from a visitor,—a child from Yarmouth, who had not fully recovered from a sore throat, at the time not supposed to be diphtheria. Three of the children died; the fourth recovered. The house in which the family resided being situated near the sea-shore, remote from any other, the disease did not spread.

Brighton.—Diphtheria commenced in June, and lasted for more than a month; it reappeared in September, and has continued since, occasional cases arising now. As to the cause, I am not satisfied in my own mind. Most of the cases were among the poorer classes, living in tenement-houses, and overcrowded.

Brimfield.—All the cases of diphtheria I have ever seen have, I think, been traceable to bad surroundings; namely, sinks, privies, or damp rooms. My own experience is, that typhoid fever, diphtheria, and erysipelas, especially the former, are always associated with bad surroundings.

Brookfield.—I have not supposed what little of the disease we have had could be attributed to any surroundings or particular locality.

Cambridge.—We have had no serious epidemics of this disease. The few cases I have seen included various nationalities, both sexes, and the patients were nearly all under thirty years of age. . . . Generally the hygienic surroundings were bad, the drainage being defective, the cellars damp and filthy, and offensive smells abounding; but sometimes cases have occurred in well-appointed houses, where no cause could be found for the existence of the disease. A large majority of the cases occurred where the sewerage was not satisfactory.

Charlestown.—In every case of which I have been personally cognizant, there has been found, upon examination, defective drainage.

Charlemont.—The forty cases occurring in Buckland, Charlemont, and Florida were within fifty feet of the river level; many of the cellars were damp, and some of the tenements too much overcrowded.

Chelsea.—We have had some diphtheria, hardly an epidemic. My suggestions are, better drainage for the city, more attention to the ventilation of cellars, less occupation of basements as sleeping-rooms.

Chilmark.—About twenty years ago, I met with several cases of diphtheria of great severity. They were the first cases I ever saw, and I might almost say my only ones. They occurred in two contiguous farm-houses, located on damp, heavy soil, with an underlying stratum of white clay. One of the cellars was habitually wet. Both families were in good circumstances, and their houses and surroundings clean and comfortable. . . . There were four cases in one house and three in the other. A young man who lived a mile from them, and was a frequent visitor at one of the houses, contracted the disease, and came near dying.

Clinton.—All localities were apparently invaded, high and low, wet and dry; where the hygienic surroundings were satisfactory, and the contrary. In one family, five had sore throats with fever and prostration; the drains gave off an abominable stench; in no other case did I find anything to give offence. Soil, clayey; subsoil, "hard-pan"; water-supply from wells.

Dartmouth.—The disease was confined almost entirely to Dartmouth Centre, which is a low country, surrounded on all sides by hills. Ten of the twelve patients seen by me attended the village school, which is situated in a very low, swampy place, so much so that flag grows in the yard.

Dennis.—I have had but two cases of diphtheria, and both came from Gloucester. . . . I think diphtheria seldom prevails to any alarming extent on a purely sandy soil. . . . I have practised medicine in this locality for twenty-three years, and never saw in my practice more than about six cases.

Dover.—We have a sparse population, with a large proportion of high land. The flat lands are gravelly and light. In 1862–63 the winter was mild; diphtheria broke out suddenly, the first case being in a child of six years, and fatal. This disease pursued a capricious course, passing up a long street, skipping one house and taking the next, one out of a family, and then every member. . . . No endemic causes seemed to have any influence; the disease seemed in the atmosphere, and was apparently in no instance communicated from one person to another.

East Boston.—Among the foreign population, living on the made land and upon the uplands where there are no sewers, diphtheria and scarlet fever have been quite prevalent and fatal within the past two months, more or less. I have not had a large number of cases of diphtheria under my care. In every severe case that I have seen, there have been imperfections in the drainage.

Falmouth.—Diphtheria appeared to me to be contagious; one patient coming from out of the village was taken with it. A sister soon after came down, and then the nurse. All three died. Several others in the family suffered with severe sore throats. The nearest neighbors also contracted the disease, but none others in the village. During the present fall it has, so far as known, been confined to three families (neighbors).

Fitchburg.—No portion of the city has been exempt from cases of the disease, but they have been more numerous in some localities than others. This is especially true of the low lands bordering upon the Nashua River, in the southern part of the city. Other than location, the hygienic conditions are not especially unfavorable. The soil is light and sandy, and the subsoil a coarse gravel.

Gloucester.—Some cases occurred in elevated, dry positions, well drained, etc.; others in low, wet situations.

Great Barrington.—The cases occurred in instances where the dwellings were old, and decayed timbers were under them, or rooms were built without cellars under them, or the drainage was badly arranged about the houses. Dampness and foul air had their influence in every case.

Hadley.—In December, six cases of the disease occurred in a family which kept a rum-hole of the lowest class. All the surroundings were of the filthiest possible character; dirt in the house; tobacco hung in a shed, close by the kitchen; garbage all about; personal uncleanliness and irregular life,—all conspired to entice disease. Water for drinking and cooking was taken from a well close on the border of the barnyard, which had a half-dozen pigs in it. There had been no known exposure to the disease. Four children died within a few days of each other; then a hired man, intemperate, but vigorous, aged thirty, followed. The sixth case, a young married woman, was removed soon after being taken, and recovered. An American, intemperate, from North Hadley, called in to see the family, was taken with the disease, and died in three or four days. This man's mother had it afterwards, and died. An Irish neighbor, a half-mile distant, visited the family, and had the disease immediately, but recovered; a child of his died of it a few days after. Soon, some five or six cases occurred in American families, but it was mild. These lived a mile away. Since then, within a week, one Irish child, who lived two miles off, has died. . . . With regard to the house especially mentioned, I would say that it is shaded very much, and the cellar must be filthy; but the situation is good, the soil being about two feet of loam with a subsoil of sand.

Hanson.—Until within a week, it has been confined to one part of the town, almost wholly on one street, which runs north and south, and along which the land is low. This is always the most unhealthy part of the town. Seven died, out of sixty cases.

Hardwick.—There was nothing to lead me to believe that the patients' surroundings had anything to do with the disease, any more than it has at all farm-houses. They are nearly all alike in this vicinity. The drainage from the sinks is usually upon the surface; the wells and privies are in juxtaposition, with the hog-pen not far removed; the sleeping and living rooms are all poorly ventilated, the cellars without any ventilation whatever; some never see the light of the sun.

Hatfield.—Localities invaded, wet; origin, I do not know; circumstances good; surroundings of the patients healthy; living-rooms airy and well-ventilated; cellars wet, not sunny; sinks empty on the surface; privies on the surface; soil rather wet, most of it subsoil clay; drainage poor; sewerage, none; water-supply good.

Haverhill.—During the month of November an epidemic broke out with some violence in Mount Washington, so called, an elevated, sandy region of the city, rather sparsely populated; about a dozen cases occurred. . . . The houses were new and well drained. Being in a sandy bed, the cellars were dry. Most of the children attend school in a large, new and fine building, located near a swamp, formed by the drainage of Silver Hill. A large deposit is held in the basin, and the question has been raised, To what extent can the disease be traced to this condition? The drinking-water of the school-house is pumped from the river, without much filtering; the houses are mostly supplied by the Haverhill aqueduct, from ponds. We have good sewerage in many parts of the city. The Irish population has been largely exempt from the disease. The portion of the city most thickly populated by the Irish is most defective in drainage.

Heath.—Sixteen years ago, the disease prevailed very extensively. I had over one hundred cases in one year, and lost ten per cent. of them. This was in the towns of Heath, Halifax, Whitingham, Readsborough, and Rowe; since then it has prevailed more or less every year. I cannot give any cause as to the disease.

Holyoke.—The disease has invaded all parts of the city, high and low, wet and dry, and about equally. It has invaded the well-constructed, elegantly furnished, and thoroughly ventilated homes of the wealthy and the cultured nearly or quite as often as the ill-constructed, meanly furnished, and poorly ventilated hovels of the poor and ignorant. It is a question in my own mind whether the modern water-closet, located, as it often is, in close proximity to the family sleeping apartments, is not a fruitful source of this and other diseases of a typhoid type. At least, I oftener meet with it in houses possessed of these so-called modern conveniences, than elsewhere.

Hudson.—Most of the cases have been on low land with imperfect sewerage, and, in some cases, privies not properly attended to; soil damp; living-rooms on the north side of house; water-supply good.

Hyde Park.—High land and low, wet and dry, have presented cases; but a large portion of our high land is filled with springs, which render cellars and contiguous land wet and damp constantly.

Lawrence.—It prevailed in all parts of the city; but the cases which I saw were, for the most part, in localities where the patients were exposed to dampness, as in rooms over wet cellars, or where there was little sunny exposure, and, perhaps, imperfect sewerage. Many cases, however, did not come within this description. Some cases were school-girls, who, having perhaps a peculiar susceptibility to the disease, were attacked after exposure to wet. Unquestionably, the want of good sewerage, and the emptying of sewage on the ground around houses and in back alleys, have been the occasion of some cases of diphtheria during the year. At any rate, the condition and the disease coëxisted frequently.

Leicester.—The family attacked lived under an old church where the rooms were low and dark. The sinks and privies both drained into the well. . . . At the wake following the death of one of the children, five young servants living in the village stopped over night; two had diphtheria, two slow

fever, and the fifth had high fever and profuse diarrhœa. The family moved to another tenement. There were no other cases in town.

Littleton.—All cases occurred in dry, sunny, good houses, and with well-to-do families. No supposed origin.

Malden.—A number of cases have occurred in a small settlement, situated upon a very considerable elevation, numbering some twenty houses. This hill, a rocky eminence, has a fine natural drainage; but there is no depth of soil above the rocky substratum, and no system of common sewers, so that the thin layer of earth into which the privies and cesspools necessarily empty, soon gets saturated. Diphtheria may be said to be endemic in this locality.

Marshfield.—There were three cases in one family this year, and no others; they made their appearance simultaneously, and occurred in a wet, marshy place. The family had recently come from Boston Highlands.

Montague.—The cases that occurred in February and March were mostly on low land, though not wet or marshy; those in September were on higher ground, dry, light soil and gravelly subsoil.

Nantucket.—I could not account for the prevalence of the epidemic (of 1860). It came, as influenza has come here more than once, affecting many persons; but it was not influenza. Some cases occurred, where dampness of the soil and locality might have had an influence. The water here is good, but it is very possible that some of it may be injured by the vicinity of privies and drains to the wells. The town is compact, and, as the soil is sandy, water soaks away quickly, and but little thought has been given as to where offensive liquids go, so that they get out of sight and smell. Since 1860 the disease has not prevailed here, nor did it for fifteen years previous to that time.

Natick.—An open drain receives the wash and sewage from Walnut Hill. It is also a receptacle for dead cats, rats, and other useful animals. Standing upon the edge of this, a biscuit could be tossed into the beds where were sixteen cases of typhoid fever and dysentery of a typhoid type, the exact proportion of which were fatal I cannot say; but there were several deaths. This drain is a natural estuary of Pegan Brook, and all this filth goes into Lake Cochituate, especially after a rain. Diphtheria did not, in any case, seem endemic here; but prevailed in damp, open weather in winter and spring. It does not seem to have been influenced by any discoverable local cause, and was as often fatal in a high, airy, sunny locality as in a low hovel.

Needham.—My two cases occurred in the houses of wealthy people, situated on the south side of a hill. The cellars are more or less moist in consequence of the rocky soil and being on the side of a hill.

Newton.—The cases under my care in August were on very low ground on the banks of the Charles River, only a few feet above high water, in old houses with bad surroundings, soil wet, of course; two others in adjoining houses—equally bad, if not worse. The case I saw in winter was in a good

neighborhood on a gentleman's place, but the air was bad from the neighborhood of stables, etc.

Newton Lower Falls.—There have been seven cases of diphtheria, six fatal; three adults, three children. Two of the cases were in an old tenement-house, near the river, on a hillside on a corner. The house was not in a very bad condition, but the well was where a good deal of surface and sink water ran into it. The well, an open one, was close to the house in the angle between the L and main house. The privies were about forty feet from the well, but the vaults were not close. In this house two children died; there were no other cases in it. Two other cases were on the Needham side of the river, in a small story and a half house and shop, together. The house was clean, with good cellar, faced the south, and was quite open on three sides. Nothing about it to be noticed. The water came from an old well on the roadside some distance from the house and some distance from privies. This first case was of a barber and harness-maker, who died; then his sister was taken sick and died.

The other three cases were on a side street in a comfortable, well-to-do family, living in a small story and a half cottage-house, on high ground back from the street, plenty of room all about the place. The well, however, was on one side of the L, the privy opposite it across the L, not more than twelve feet apart. The sink-spout ran back some distance in the garden. The vault to the privy was not a close one. The first case here was a child of eight, who died, then the aunt, and now the mother is quite ill.

North Adams.—I am not a believer in the contagiousness of diphtheria; and, from my observations of this disease, I cannot lodge it or find its hiding-place, or the causes that develop it; for the past two years I have hardly been free from cases. One fact, I think, is established in this region: that high elevations are more subject, and with greater fatality.

North Reading.—Since the great epidemic of diphtheria, ten years ago, people are apt to call every sore throat by that name. I have not seen a well-marked case during the last eight years.

Orange.—In 1848 the disease first made its appearance; from that time it has occasionally cropped out in sporadic cases, and occasionally as an epidemic. From 1862 to 1865 it prevailed epidemically throughout this region, and at times was quite fatal. Since that time the disease has occasionally appeared, but mostly of a mild character. During the past year there have been quite a number of cases, most of which were mild. I do not know that any localities have been entirely exempt from the disease during its greatest prevalence and severity; those living on high land have suffered alike with those on low land, and such as lived on dry, light land as well as those on moist, heavy land. I will not attempt to account for the appearance of the disease; being so wide-spread and general in its prevalence, it is difficult to arrive at any satisfactory explanation of its cause. If close living-rooms, damp and dirty cellars, badly-cared-for privies and sinks, careless sewerage, etc., are productive of diphtheria, I should expect to see a perennial epidemic of the disease in some localities.

Orleans.—I have not seen a well-marked case of diphtheria during the year; cases of ordinary diseases of the throat are, in my opinion, often passed off for that disease, and generally with a motive.

Peabody.—I have not observed any peculiarly unfavorable conditions existing in the surroundings of the patients thus far treated by me for this disease.

Pembroke.—I have had thirteen cases in a recent epidemic at South Hanson. The location of my patients is a lane, running down to one of the Halifax ponds—a swamp on both sides of it; soil wet; drainage on the surface. The people are very poor, living huddled up in small houses.

Pepperell.—The cause could not be detected, as cases occurred both in elevated and low locations, among the most cleanly and refined people as well as the opposite. The cases of recovery, however, were uniformly among the former.

Pittsfield.—Of the forty-five fatal cases occurring during the last two years, not one has been in the best class of dwellings. The disease has been limited to the poorer class, and chiefly foreigners. The families generally lived in small, overheated rooms, poorly ventilated, and the children ran out into the open air improperly clad. The diet, too, was generally inferior. Sanitary defects outside the house could generally be found, but not always. The cases were scattered all over the town. The cellars were generally dry —few are otherwise here; water is the best; the houses sunny. The origin of the first cases in any family was generally obscure, but contagiousness was very marked in families, and frequently traced from house to house.

A very fatal but limited epidemic occurred in Lanesborough last summer. I think eight persons died, being nearly all that were attacked. It began in a family of extraordinary filthiness, in which the cases were most malignant. The other cases were neighbors who had been directly exposed to contagion. This epidemic, apparently, was carried from Pittsfield by infection.

Royalston.—This town has recently suffered from an epidemic of diphtheria, attended with alarming fatality. Of twenty patients attacked, twelve died. With the exception of the children, those subsequently attacked, after the first case, were those who had either watched with the sick or assisted in laying out the dead. The cases I visited were in healthy localities; drainage and sewerage good. I should judge, however, from what I can learn, that the conditions were quite the reverse in the house where the disease originated.

Another correspondent writes: "Each case, except the first, could be traced exactly to exposure to a previous one. Seven adults and five children died. A woman washed the linen of the first family on Tuesday, and died at six o'clock P. M. Thursday, of the same week."

Salem.—It can hardly be said that we have an epidemic of diphtheria, yet this disease is more wide-spread and frequent than it has been for many years. It has seemed to develop itself most easily in young children, yet it by no means infrequently attacked adults. Persons of both sexes, and of all nationalities, seem to be equally susceptible to its specific poison. We cannot find that one section of our city above another has been exempt from its visitations. Families in dwellings on high land, with good drainage, and whose method of living seemed conducive to health, have suffered from this disease in common with those living in damp, undrained, and filthy houses. The number of fatal cases of diphtheria has been comparatively

small. The disease has generally subsided in from five to ten days. It has been noticed that in families where well-characterized cases of diphtheria occurred, other members were at the same time affected with slighter inflammations of the throat. This we are inclined to regard, not as the effect of the diphtheritic poison, but as the result of the general hygienic surroundings or atmospheric conditions which favored development of diphtheria in the others. Associated with diphtheria, there has been a marked prevalence of various forms of sore throat. It may magnify the skill of a physician to persuade people that he has cured a patient of diphtheria in two or three days, when he has to deal only with a comparatively mild throat distemper; but he is likely to raise expectations which he will fail to satisfy when he is called to treat active manifestations of a true diphtheria. And worse than all, he is likely either to needlessly alarm some households on the one hand, or on the other to create the opinion that diphtheria is a trivial disease, which can be easily and quickly controlled. Such an underestimate of disease is likely to lead to fatal postponement or neglect of treatment. We cannot help noticing that during the last four months there has been a marked tendency to affections of the mucous membrane of the respiratory organs, since, together with bronchitis and pneumonia, we have had associated the prominence of laryngeal and bronchial symptoms in measles, and the throat symptoms of diphtheria. We have no data which as yet satisfactorily explain why diphtheria should appear at this season rather than formerly, or why it should distribute itself as it has.

Saugus.—The localities and surroundings in my cases have been all favorable to health. The supposed origin of the first cases was in a small party for boys and girls, where one of the number was already sick and afterwards died, several of the others being attacked within a few days.

Shelburne.—In one family where there were six cases, the house was well ventilated, the family neat and cleanly, the house on high land; but through the spring the soil around the house was saturated with moisture, and the cellar very wet and containing a large quantity of vegetables. In another family, where five cases occurred, the house stands on high and dry ground, well ventilated, with dry cellar. In each of these houses the light of the sun to the rooms is obstructed by piazzas.

South Hadley Falls.—Diphtheria has been most common and severe in that part of the Falls village which has lately been built upon a swamp, with miserable drainage, if any.

Southwick.—The cases were among farmers, in apparently healthy locations. The cellars are dry, and the living-rooms such as we find in most of our farm-houses. No sinks are used in the houses; but the wash-water is thrown out on the surface of the ground, near the wells from which water is obtained, where it may sink through the soil of sandy loam and gravelly subsoil to contaminate the water of wells.

Springfield.—Diphtheria has been limited to localities and isolated families, and evidently caused by dampness, bad water, defective drainage, no sewerage, and infection or contagion from carelessness in families while existing. It has, in many instances, been confounded with pharyngitis, tonsillitis, and follicular inflammation. Consequently, exaggerated statements of its prevalence have obtained.

Stoneham.—The two deaths referred to occurred on a hill with moderately good surroundings. A marshy piece of land lies on the foot of the hill a few rods distant; no drainage and no sewerage.

Another physician says, "Most of my cases of diphtheria occurred in families living on high ground, and I could find no hygienic circumstance looking toward the cause. I feel confident that after the first case in a family, the chief cause was contagion."

Taunton.—Causes of diphtheria here are dwellings in swamps, prevalence of north-east winds, with the air heavy, cold, and changeable, and the use of surface-water or swamp-water for domestic purposes.

Wakefield.—I have observed that wet and cold hillsides, *i. e.*, with northern and western exposure, have been rather the favorite habitats of diphtheritic attacks.

Wareham.—I should say that I had treated fifty or sixty cases in the last twelve years in this town and vicinity, with a loss of perhaps one-fifth, and about the same number of cases in the months of January, February, March, and April, 1861, in the town of Sterling, with a fatality of more than one-third. In this vicinity, all localities were invaded alike. I think the disease as contagious as scarlatina.

Watertown.—The cases that I have seen (not fatal) have occurred in houses which, in respect of sanitary matters, are fully equal to the average habitations of the middle and lower classes; none of them were tenement-houses with more than two families. The fatal cases of which I hear were in localities where the soil is moist and the drainage must be defective.

Webster.—The cases that have occurred here (sporadic) have appeared under all sorts of circumstances and conditions of life, and were not traceable to any particular condition.

Westborough.—The cases occurred in families with very comfortable surroundings, in sunny rooms, in two cases, with apparently good drainage; soil, a light loam, with sandy subsoil; water supplied from wells.

Westfield.—Surroundings of patients seem to have made but little difference here. Imperfect nutrition, and sudden changes of temperature of the body, seem to constitute the appreciable causes.

Westford.—Cases occur in this town more along the water-courses and on the low grounds; very rarely on the hill.

West Springfield.—The houses in which diphtheria occurred were in damp localities, occupied as tenements, of few rooms each, so that overcrowding was added to bad situation. The lower part of our town lies on low ground, protected by a dike from spring freshets. It has lately been rapidly built up with houses close together; a sewer opening below high water has been commenced, but from "economy" left uncompleted. There are few, if any, connections with houses. The soil is here alluvial, resting on quicksand; water is reached at a depth of about eighteen to twenty-five feet. The

houses are occupied mostly by railroad employés, not remarkably cleanly; and, what with the proximity of wells and privies, with kitchen-sewage generally conducted to a closed cesspool, necessarily not far from the house and well, everything seems ready for an epidemic when the soil in time gets sufficiently soaked or the necessary "germs" come this way.

Winchester.—I believe that the prolonged cold of last winter and early spring lowered the "tone" of health and diminished both the resisting and recuperative powers of the population. . . . One of my worst cases was over a wet cellar, in a springy and undrained meadow, but in an isolated house, in an unhealthy family of six. There was no other case in the family.

Worcester.—My cases have all occurred where there were no sewers, but the houses were not in bad hygienic condition.

The few reports following, although not relating to the subject of diphtheria, are inserted, as dealing with matters of considerable importance. The two cases of poisoning deserve general attention, the second of them with special reference to legislation, which is evidently required. No comment is needed on the sanitary condition of the camp, farther than has already been made by the surgeon-general.

Lowell.—On the afternoon of Sunday, December 12, three boys had been rambling in the fields on the line of the Concord River, not far from the Boston & Lowell Railroad bridge, when, becoming very hungry, they ate some cranberries which they found on their way. Afterwards, at about three and one-half o'clock, having come upon a potato field, formerly a meadow, and but recently dug up, they discovered some roots lying on the surface. Taking them to be carrots, the boys broke off some pieces, and eagerly devoured them.

Two of the lads (they were about fifteen years old) went home, and in about half an hour after leaving the potato-field were found, each on the ground, in convulsions. There was, in each case, a feeble attempt, at first, at vomiting, but with scarcely any result. The convulsions quickly became more severe, and death ensued in an hour after.

The third boy, who says he had eaten three of the tubers about to be described, having heard of the critical situation of his comrades, became alarmed and ran home, a distance of about a mile, where he arrived at twenty minutes of five. On the way he felt a little dizzy, and the "taste of the root he had eaten kept rising in his throat." On entering the house, he told his mother he was sick and wanted to vomit, drank half a cup of an infusion of lobelia that had been prepared for his sick father, then some warm water, and in a very few minutes threw up a large quantity of the so-called pieces of carrot, together with some cranberries, a part of which were undigested. He immediately staggered and stiffened out in convulsions. In a short time he came out of the fit and then lay pale and exhausted. Whiskey was largely administered. Convalescence began in six hours, and in forty-eight he was well.

The root with which these boys were poisoned belongs, according to the botanists, to the *cicuta maculata*, a perennial plant commonly called American

hemlock, spotted cowbane, etc., and is probably the most poisonous of our vegetables. There is an excellent description of the plant, with a colored engraving of the upper part of it, in the first volume of Bigelow's Medical Botany, where also are given cases of poisoning with symptoms similar to those just described.

The plant itself reaches its growth in midsummer, when it presents quite a conspicuous appearance in our wet meadows, grows to the height of a man's head, bears a green, parsnip-like, serrated foliage, and bears at the summit of its branches clusters of minute white flowers, like those of the carrot, parsnip, etc. The stem is often spotted or maculated, hence the specific name of *maculata*. But the general appearance of this plant is apt to be confounded by the unbotanical eye, with other members of the family of *umbelliferæ* to which it belongs. The distinguishing feature is the root, which is composed of a number of large, fleshy tubers that are attached to the central stalk, like the root-growths of the dahlia, and bear a general resemblance to fingers in size and shape.

During the growth of the plant the fluids are, of course, distributed throughout the entire structure; but, after the stem performs its office and decays in the fall, the juices accumulate in the root. The poisonous principle consists of a yellowish juice stored up in the cortical portion. The central part of the root is a white, mealy pith. When a tuber is gently pressed, the yellowish juice oozes out in resinous, glistening drops, and emits a pungent, aromatic odor, somewhat like that of parsley or celery, which, together with coriander, anise, lovage, etc., belong to the same family.

During the past year, the statement was published that illness had been caused in a box-factory in Lowell, from the use of arsenical paper. The case was investigated by Dr. E. G. Cutler, of Boston, who made the following report:—

"Of a collection of seventeen girls who had worked some time at the trade, four have been variously sick; of these, three have ceased to work at the factory, while the fourth still remains, though temporarily absent. The details of these cases, so far as could be ascertained, are given below:

"*Case* 1. A young woman who had been at work at least a year, took sick of consumption; the disease ran its usual course, and ended fatally. Her disease was not attributed to her employment.

"*Case* 2. A young woman, previously healthy, after working some time, had a swelling on one finger, an eruption on her face, headache, nausea, pallor, and sore eyes. She attributed her illness to her employment, gave it up, and made a speedy recovery.

"*Case* 3. A young girl of eighteen, previously healthy, who had worked at least one year, and during that period was at times more or less ill, consulted her physician with the following condition of ill-health: General pallor of a marble-like color, universal swelling, languor, tendency to sleep, nausea more or less pronounced, occasional vomiting, headache, some intolerance of light, accelerated and feeble pulse, coldness of extremities, sluggish appetite, an anæmic heart murmur. She gave up the business, and made a speedy recovery under the use of simple remedies. She has not again resumed the work, and remains well.

"*Case* 4. The patient is now in a very low condition, from chronic disease of the kidneys. Her attending physician attributed her sickness to other causes than her employment.

"The manufactory was found to be in the second story of a wooden building, whose ground floor was occupied by a blacksmith. The work-room is seventy feet long, thirty feet wide, and eight feet high, lighted by fifteen windows, heated by three stoves, and well ventilated; in it work fifteen girls, from seventeen to twenty years of age, two men (the heads of the firm), another man and a boy. All were good-looking, strong, healthy people, above the average intelligence. The work is done at a counter, three feet high, which runs around the sides of the room. The girls have been in the same occupation for periods varying from two to seven years, and have all, without exception, had the average good health of young people of their age, occasionally absent for a day or two, but never for as much as a week at a time; all are graduates of the high school. The pasteboard for the boxes is cut and scored by machinery down stairs, brought up, bent into shape and glued by the man and boy, and given to the girls to be covered with the green or red paper used for this purpose. The red paper is a vermilion. The green an arsenical, known as Scheele's green, with sizing. An analysis of this paper, by Prof. W. R. Nichols, gave '8.96 grains metallic arsenic, or, if reckoned as white arsenic,—*i. e.*, arsenious acid,—it would be 11.84 grains to the square foot.' The colored paper is cut to the proper shapes and sizes, at frames in the centre of the room. These strips are arranged in piles at the side of a girl, who applies to them a flour paste, and then sticks the paper on the box, smoothing the sides of the box and the top of the cover with a brush. In this process the fingers do not come in contact with the pigment. The sides of the cover are applied by the fingers, and in the smoothing process a certain amount of the green pigment is rubbed off on to the hands, which are washed at short intervals. A protector, with long sleeves, and high in the neck, is worn over the ordinary clothing. The mouth and nose are not covered by protectors. The green paper is kept in large covered packages in the work-room, to the extent of several hundred weight. There was scarcely any dust or dirt to be seen anywhere, except on the window-sashes where the hand brushed along gathered up a slight amount of dust, with a scarcely perceptible green tinge; also from the cutting-frames in the centre of the rooms, a dust, distinctly green, was rubbed off; this had no specially irritating property when inhaled. The amount was very small in each case. The hands and faces of the employés were free from eruptions of any kind, and their red cheeks and lips gave pretty good evidence of their good health, in addition to verbal assurances to that effect.

"In considering the cases above detailed, it is evident that two of the number can be directly traced to the arsenic; the symptoms are characteristic of the anæmia from this form of poisoning. Of the remaining two, a proper estimate of the effect of the poison in the causation or aggravation is impossible. The presumption, however, is, that it increased the effects of the disease. The fact that so small a number of cases of illness has occurred in an employment which deals with such a poison as arsenic, is striking, when compared with many other manufactories. Its cause is to be found in the great care which the employers have exercised for the comfort and health of their help, in the intelligence and tidiness of the latter, and in the fact that the paper is heavily sized."

Lynn.—The following table gives a few facts of interest with regard to the relation of sewers to disease in our city; although the facts are given for only one year, they are certainly very suggestive:—

DISEASE.	No. of deaths in 1875.	No. in streets containing sewers.	No. in streets containing no sewers.	Of uncertain residence.	No. per thousand of estimated population in streets containing sewers.	No. per thousand of estimated population in streets containing no sewers.
All causes (omitting still-births and violence), .	617	106	489	22	12.84	19.75
Pneumonia, . . .	41	3	37	1	.36	1.49
Scarlet fever, . . .	57	6	48	3	.72	1.93
Typhoid fever, . . .	21	6	15	–	.72	.60
Diphtheria, . . .	11	2	8	1	.24	.32
Consumption, . . .	118	21	92	5	2.51	3.71
Cholera infantum, . .	43	8	35	–	.97	1.41

The significance of the figures in this table is increased when we consider the following facts:—

1. The streets containing sewers compose the most densely populated parts of the city.
2. Many of these streets are among the most ill-conditioned in the city,* and they are largely occupied by a class of people who are careless of sanitary matters, and among whom the mortality is usually great.
3. The sewers have, for the most part, been constructed within a few years, and time has not been afforded for their full effect to be manifest.

The following insanitary condition of one of our camps for summer drill has already been reported† to the surgeon-general, and referred to in his report in no doubtful terms of condemnation:—

South Framingham.—The diseases, as usual, were principally diarrhœa and cholera morbus, beginning with a few cases, and increasing until, on Friday (the last full day in camp), the surgeons were busy the greater part of the day and evening. The cases were not serious, owing, no doubt, to the short time the camp lasted. Several reasons might be given for the sickness, such as change of habits, food, overcrowding, and bad ventilation of the tents; but the most obvious one, I think, is the poor quality of the drinking-water. The wells are about twenty (20) in number, four (4) being near the arsenal, and not much used by the soldiers; one is at brigade headquarters, a new curb-well, about eighteen feet deep. The others are scattered over the camp near where the cook-houses are generally erected, and not very far distant from where the sinks are dug; these are: six new stone, about sixteen feet deep; four wooden curb, eighteen to nineteen feet deep; four new brick, twenty to twenty-two feet deep; one old brick, fifteen feet deep.

* The estimate of the population of the sewered streets was made by the city engineer. It was 8,250, or one-fourth part of the whole, leaving about 24,750 for the remainder.

† The surgeon making the report has very kindly sent us these notes, and they are inserted with the permission of the surgeon-general.

The soil is gravelly, and after a heavy rain the ground is very soon dry; puddles six inches deep disappearing entirely in an hour's time after the rain has ceased falling. Each pump has a large wooden tub for the use of the men when washing. Last year (1874) the water came up soapy, as the tubs were emptied near the pumps; this was partially remedied this year by having the tubs removed eight to twelve feet from the pumps, and connected by a wooden trough.

There is no system of drainage to carry off the water and slops from the vicinity of the wells. The sinks are dug from two to three feet deep, in different places for each brigade, and without much regard to the proximity of the wells.

The water is no doubt all that could be desired, were it not so readily contaminated by the surface-drainage.

The state authorities are about putting up a fence around the camp-ground, at an expense of about $4,000. It is generally conceded that this money would be much better expended if used to grade and drain the land.

Population, estimated from the Census of 1875, and Death-rates in the Cities and larger Towns of the State, for the year 1875.

Cities and Towns.	Population.	Deaths per 1,000.	Cities and Towns.	Population.	Deaths per 1,000.
Boston, . .	342,000	26.2	Peabody, .	8,060	21.3
Cambridge, .	50,000	22.4	Brookline, .	7,800	17.1
Lowell, . .	49,688	20.5	Marblehead, .	7,677	25.4
Worcester, .	49,265	22.1	Natick, . .	7,000	14.7
Fall River, .	45,340	26.2	Clinton, . .	7,000	19.3
Lawrence, .	35,000	27.5	Plymouth, .	6,700	16.4
Lynn, . .	32,600	20.8	Danvers, .	6,500	17.2
Springfield, .	31,050	21.4	Hyde Park, .	6,288	21.6
Salem, . .	26,000	23.1	Amesbury, .	5,987	21.0
New Bedford, .	25,876	24.2	Southbridge, .	5,780	20.2
Somerville, .	22,000	22.7	Dedham, .	5,756	15.9
Taunton, .	20,429	21.1	Spencer, .	5,446	21.8
Chelsea, . .	20,000	22.3	Wakefield, .	5,349	19.4
Gloucester, .	17,000	22.3*	Leominster, .	5,203	20.3
Holyoke, . .	16,260	26.5†	Framingham,	5,167	21.2
Adams, . .	15,600	19.0	Westborough,	5,140	19.4
Haverhill, .	14,700	16.3	Andover, .	5,100	18.6
Newburyport, .	13,323	23.1	Webster, .	5,059	18.3
Fitchburg, .	12,289	16.1	Middleboro', .	5,023	16.5
Pittsfield, .	12,255	22.5	Stoneham, .	4,984	18.4
Northampton, .	11,500	20.7	Stoughton, .	4,842	17.3
Malden, . .	10,843	19.2	Hingham, .	4,654	20.6
Brockton, .	10,578	17.8	Provincetown,	4,557	17.1
Waltham, .	10,000	17.5	Millbury, .	4,529	16.1
Weymouth, .	9,880	15.9	Hopkinton, .	4,503	22.8
Milford, . .	9,800	20.2	Rockport, .	4,490	17.8
Woburn, . .	9,568	21.8	Grafton, . .	4,442	14.6
Attleborough, .	9,329	16.5	Barnstable, .	4,302	22.3
Quincy, . .	9,142	19.4	Methuen, .	4,205	17.1
Westfield, .	8,429	17.0	Canton, . .	4,192	11.9

* Excluding 123 lost at sea.

† Excluding 71 deaths by the fire.

*Estimated Population and Death-rates reported by the Registrars of American Cities, for 1875.**

CITIES.	Population, (estimated.)	Deaths per 1,000 living.	CITIES.	Population, (estimated.)	Deaths per 1,000 living.
New York, . .	1,053,819	29.10	Reading, . .	40,000	21.62
Philadelphia, .	825,594	21.56	Paterson, . .	38,898	29.28
Brooklyn, . .	500,000	24.78	Lawrence, .	35,000	27.54
Chicago, . .	420,000	18.80	Minneapolis, .	35,000	16.28
Baltimore, . .	350,000	20.72	Quincy, . .	35,000	15.60
Boston, . .	342,000	26.18	Wilmington, .	35,000	24.45
Cincinnati, . .	265,000	20.39	Atlanta, . .	35,000	22.57
San Francisco, .	240,000	18.44	St. Paul, . .	33,500	14.17
New Orleans, .	210,000	29.13	Lynn, . .	32,600	20.82
Louisville, . .	150,000	17.20	Springfield, .	31,050	21.44
Pittsburgh, . .	140,000	21.12	Peoria, . .	30,639	13.05
Detroit, . .	116,000	19.70	Harrisburg, .	30,000	14.60
Providence, .	100,675	19.02	Wheeling, . .	28,000	17.21
Richmond, . .	72,639	21.84	Salem, . .	26,000	23.10
Allegheny, . .	67,000	12.70	New Bedford, .	25,876	24.20
Syracuse, . .	60,000	18.55	Trenton, . .	25,700	9.10
Charleston, .	56,540	32.97	Fort Wayne, .	25,000	17.52
New Haven, .	55,000	22.29	Dubuque, . .	25,000	10.64
Cambridge, .	50,000	22.38	Bridgeport, .	25,000	13.92
Scranton, . .	50,000	7.00	Terre Haute, .	25,000	13.88
Columbus, . .	50,000	13.60	Norfolk, . .	23,000	20.21
Toledo, . .	50,000	16.18	Somerville, .	22,000	22.70
Memphis, . .	50,000	23.06	Little Rock, .	20,475	16 01
Troy, . . .	50,000	10.00†	Poughkeepsie, .	20,080	26.29
Lowell, . .	49,688	20.52	Taunton, . .	20,469	21.07
Worcester, . .	49,265	22.12	Denver, . .	20,000	9.75
Fall River, . .	45,340	26.17	Chelsea, . .	20,000	22.25
Hartford, . .	45,000	13.04	Springfield, Ill.,	20,000	16.85
Mobile, . .	40,000	15.05	Augusta, Ga., .	20,000	20.70

* In some of these cities, registration of causes of death, or even of deaths, is not entirely satisfactory. Our last return from St. Louis is for 1874, when a death-rate of 14.45 was reported for an estimated population of 450,000.

† Given as "about" that rate.

The death-rate in London for 1875, with a population estimated in the middle of the year at 3,445,160, was 23.7. In "Greater London," as bounded by Sir Robert Peel, extending over the Metropolitan Police District and including the suburbs, the population, estimated by a satisfactory method, was 4,207,167; the total death-rate was 22.7, and *only 3.7 from zymotic diseases.* It is interesting to compare these rates with those of Boston.[1] No comment by us is necessary.

[1] See pp. 495 *et seq.*

PUBLIC DOCUMENT...... ......No. 31.

SEVENTH ANNUAL REPORT

OF THE

BUREAU OF STATISTICS OF LABOR,

WITH AN

APPENDIX

CONTAINING A HISTORY OF THE BUREAU, AND OF LABOR LEGISLATION IN MASSACHUSETTS.

APRIL, 1876.

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1876.

Commonwealth of Massachusetts.

Office of the Bureau of Statistics of Labor,
33 Pemberton Square, Boston, April, 1876.

Hon. George B. Loring, *President of the Senate of Massachusetts.*

Sir:—I have the honor to present to the legislature the Seventh Annual Report of the Massachusetts Bureau of Statistics on the subject of Labor.

Very respectfully, your obedient servant,

CARROLL D. WRIGHT, *Chief.*

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INTRODUCTION.

Basis of this Report.

The work of the Decennial Census and Industrial Statistics of the Commonwealth for the decade ending May 1, 1875, was committed to this bureau by Act of the legislature of 1874.

This course enabled us to gain very extended knowledge of the varied interests of the State, and advantage was taken of the occasion with reference to the condition of the wage laborers. Among the inquiries established by law, was a series instituted for the purpose of securing such extensive returns as to set at rest some of the questions which had for the past few years furnished topics for investigation and discussion. These inquiries constituted by themselves one of the schedule forms used in taking the census, and the facts returned by the enumerators on this form furnish the material for the seventh annual report of the bureau. On the schedule referred to, denominated the "Individual Schedule," were twenty questions; and that they may be fully understood as to their object, results and importance, they are here enumerated *seriatim*, and as the phraseology adopted on the schedule itself was a condensed one, each interrogatory is also explained:

First. "Sex and Age" was, as will be inferred naturally, for the purpose of ascertaining to which sex the figures returned related. Of the schedules used, all were filled in this particular, a result which effectually precluded the possibility of having used sets of figures pertaining to one sex in illustrating the general condition of the other.

Second. "What is the occupation upon which you chiefly depend for a livelihood?" By answers to this, we have been able to determine the hours of labor, average wages, etc., pertaining to leading occupations.

Third. "Were you at work May 1, 1875?" This had reference to whether they were permanently engaged at that time. The question has not been tabulated, as the entire number answering were of the employed class.

Fourth. "Number depending upon you for support." Two objects were in view in the preparation of this question; first, to ascertain the number supported by males and females; and second, to arrive at the average size of workingmen's families without reference to any general average of families obtained from the people at large through the census proper.

Fifth. "Number of hours per day employed in your occupation." Through answers to this question, we learn, as was designed, the average number of hours per day that males and females are employed, throughout the State; showing in which occupations they exceed the legal limit, or in what locality such excess exists.

Sixth. "Number of days employed during the year ending May 1, 1875?" Answers to this establish the average time lost from various causes.

Seventh. "Average daily wages for working days derived from occupation during the year ending May 1, 1875."

Eighth. "Amount of wages derived from occupation for the year ending May 1, 1875."

Ninth. "Amount of your other earnings for the year ending May 1, 1875." It was regarded as particularly desirable to ascertain what proportion of the working people were enabled to procure employment during the time they might be unemployed in their regular occupations, and to learn the amount of wages received from such extra or outside work. Reference to the tables will show the importance of this question.

Tenth. "Amount of wife's earnings for the year ending May 1, 1875." The subject of receipts of the head of a family through his wife's employment has received much attention, and caused considerable vague discussion; inasmuch as no definite information upon this point, based upon any considerable number of returns, has been presented to the public, we were led to introduce this question, and the results of the investigation, as tabulated, more than justify us for sending out an inquiry which many have been pleased to term imperti-

nent. The principal object of the interrogatory was to ascertain whether the head of a family, when the wife worked for wages, could sustain his family on his own earnings.

Eleventh. "Amount of minor children's earnings for the year ending May 1, 1875." This question was suggested by the frequent legislation on the employment of children in manufacturing and mechanical establishments. Another consideration was the desire to know the truth or falsity of the following statement from a former report of this bureau, for, if true, the public should make a sentiment too positive in its character to allow a continuance of such a state of affairs as alleged; if false, the seeming disgrace should be righted. We quote from the sixth annual report of this bureau:—

"There are others also who make unjustifiable use of the plea of poverty. In one of the cities where a half-time school exists, in which the children are nearly all of one nationality, it was the testimony of the mill agent that the fathers, as soon as they had children whose united earnings would support the family, were wont to give over all personal effort, and spend their time in idly smoking their pipes in the sun, in summer, and about the kitchen or saloon stove, in winter. This was claimed to be true of the majority of fathers of children of this nationality in this mill. Among them a rapidly growing family is not reckoned as a burden, but is looked upon as the happy harbinger of days of restful ease and fumous comfort."

Twelfth. "Number of persons in your family, over eighteen years of age, prevented by continuous sickness, or physical disability, from attending to any occupation." The question explains itself, the object being to learn to how great an extent the families of working people were deprived of the average income of adult members incapacitated for work.

Thirteenth. "Do you own the house you live in?" One is quite likely to judge of the general prosperity of a working community by the answers to such a question as this.

Fourteenth. "If you own it, what is the amount of mortgage on it?"

Fifteenth. "Rate of interest paid on such mortgage?"

These two questions are really subdivisions of one general inquiry. It was our desire, through the answers, to secure

information not only regarding the amounts of mortgages and rates of interest, but to learn to what extent the homes of laborers were encumbered, and also to learn the variations in these particulars in different sections of the State. The great importance of reliable data upon these points can not be denied, for it is evident that when the members of a manufacturing community, to any considerable degree, become burdened with encumbrances upon their homes, then begins the decline of the community itself, and its financial prosperity has a duration governed only by the extent of conditions named. If we could, by any proper means, know the number of small estates which, during the past twenty years, have fallen into the hands of mortgagees, by inability on the part of the mechanic to keep his interest account square, the State would find a prolific cause for earnest and emphatic legislation. The question usually comes directly to the owner of the equity, whether he will deprive his family of ordinary support, or lose the little place he has worked so hard to secure. And yet, when this inquiry reached the people it was sought to benefit, the bureau was held up by the people, and largely, too, by the press, as an inquisitorial institution, which, if allowed to continue in existence, would seek to expose the private affairs of the citizens of the State, forgetting all the while that all matters of mortgage and foreclosure are subjects of public record.

Sixteenth. "If you hire, what is the number of rooms?"

Seventeenth. "Amount paid for a year's rent?"

The two preceding questions are very plain, and require no elaboration. Very important tabulations from answers made are contained in this report.

Eighteenth. "Value of garden crops raised by you, and used in your family, less all money expenditures on account of same." By answers to this question could be determined what proportion of families were able, by a private garden, to piece out the family income.

Nineteenth. "Cost of supporting your family (or yourself) for the year ending May 1, 1875." The division of the returns, under this question, into per capita and family presentations, gives the reader power to ascertain at once the average cost of living in different parts of the State, as well as in the State at large.

Twentieth. "Number of volumes in your private library, if the number is one hundred or over."

A question was inserted as to amounts in savings banks, but not used in the tabulations, owing to an admitted ambiguity in the form of the same.

The questions referred to, as has been stated, constituted the "Individual Schedule" of the census system. The schedule was distributed and collected as all others were, and forwarded to this office by the enumerators. It will be seen readily, that the results to be obtained from a tabulation of the answers would be a series of averages on the various points, and to give the reader an idea of the value of these averages, the extent to which the schedule was filled and returned becomes important.

The whole number received was 110,246. After a careful examination of each one, there were rejected as decidedly imperfect, 19,523, and subsequently 9,830 more were rejected; this latter number comprised all where any doubts whatever existed as to their genuineness or value, and where minors had filled a return when it was evident they had been accounted for by the head of the family. The total number rejected, then, was 29,353, leaving a total balance used of 80,893. Of this large number, 63,263 were returns from males, and 17,630 from females; also of the total number used 71,339 were from the "wage" class, and 9,554 from the "salary" class; of the 80,893 answering, 45,929 males and 1,935 females returned 142,385 people dependent upon them for support,—138,966 on the males answering, and 3,419 on the females. The average number dependent upon the males was $3\frac{2}{100}$, and on the females $1\frac{76}{100}$—while the average for both males and females was $2\frac{97}{100}$. From this statement it will be seen that there were,—

Males having dependents, ...	45,929
Number dependent, ...	138,966
Females having dependents, ...	1,935
Number dependent, ...	3,419
Males having no dependents, ...	17,350
Females having no dependents, ...	15,687
Making a total of	223,286

people represented by the "Individual Schedules," on which this Report is based.

European reports on earnings, cost of living, etc., of the wage laborers, have never been based upon a number exceeding fifty. The United States government has based its returns upon a number no larger. This bureau has used returns in different years from a number varying from six to three hundred and ninety-seven,—the number of returns used as a basis in the sixth annual report. We now, this year, base all averages upon a number of returns so extensive that their value cannot be gainsaid, and especially when it is considered that the general averages of wages and cost of living established by previous reports of this bureau, and by the National Bureau of Statistics at Washington, all based upon the most meagre returns, except, perhaps, those of last year by this bureau, are in all essential features thoroughly substantiated by the averages deduced this year from the vast number of returns at the disposal of this office. And furthermore, by comparison of the average wages derived from the returns by the wage laborers themselves, male and female, with the returns made by manufacturers, in the Industrial Statistics for 1875, so little difference is found that the absolute reliability of the averages given in this Report is thoroughly assured. Nothing could be more convincing than the following table, showing average wages as returned by employed and by employer—each made distinct from the other, both covering the same period,—the year ending May 1, 1875.

STATEMENT RESPECTING YEARLY WAGES OF WAGE RECEIVERS.

		From returns made by 71,[illegible] persons employed.	COUNTIES.	From returns made by employers, for [illegible] employés.	From returns made by 71,[illegible] persons employed.
Barnstable, .	$428 35	$362 10	Middlesex, .	$403 11	$415 34
Berkshire, .	309 74	380 91	Nantucket, .	406 65	208 00
Bristol, .	447 81	387 63	Norfolk, . .	451 48	405 98
Dukes, .	344 78	350 24	Plymouth, .	480 40	376 49
Essex, .	447 86	407 16	Suffolk, . .	642 28	452 69
Franklin, .	456 45	390 94	Worcester, .	450 01	436 81
Hampden, .	447 66	480 49			
Hampshire, .	318 10	359 12	For the State, .	413 37	418 39

From the United States census of 1870, the average wages per year for the whole State, including both sexes, as returned by the manufacturers for 279,380 employés, were $422.10.

With this brief statement relative to the materials from which the following tabulations are drawn, and upon which this Report is based, the reader is referred to the tables themselves and the notes accompanying them. The tables in Part I. relate only to wage laborers, while those in Part II. relate to those people who receive yearly salaries.

Of course no one will for a moment understand that the returns given in this volume relate to the whole people of the State, but only to those making the returns. Yet, it is perfectly evident from the comparative statements given, from the wage laborers, the manufacturers, and from the United States census of 1870, that no material difference would be apparent if every working man and woman in the State had made similar returns.

The Appendix will be found to contain a carefully digested history of the bureau and of labor legislation in this State, prepared at the request of a committee of the governor's council for the Centennial as well as for a part of this Report. The history serves two purposes,—as a contribution to the Exposition, and to supply the place in some degree of the previous volumes of reports emanating from this office, now out of print and impossible to be obtained.

The size of this Report is no indication whatever of the amount of severe labor necessary to crystallize all the facts received into tabular form. It is easy, and requires but a line, to say that the population of a State is so many millions, but the tons of paper, the condensed labor of years and the concentration of various forces requisite before such a statement *can* be made, unite to make a work to approach which seems like entering upon a life-time.

Work of the Bureau for the Past Year.

The bureau during the past year has had various and extensive duties to perform. Besides its annual report, it has taken the Census and Industrial Statistics for the year 1875. The results will be comprised in four volumes uniform with this, which is the first of the series. Volume II. will contain

the tabular presentation of returns relative to the people, libraries and schools. Volume III. will consist of abstracts relating to the manufactures of the State; and Volume IV. will contain the agricultural returns. These volumes are all nearly completed, and will be issued in a few weeks. For a fuller account of the operations of the bureau relative to the census, the reader is referred to the closing pages of the Appendix. In addition to the four volumes spoken of, we have supervised the preparation of a series of maps, illustrating various conditions of the people and the manufactures of the State, for the Exposition at Philadelphia; and a volume which contains all the instructions, blanks, circulars and schedules constituting the census system of Massachusetts for 1875.

The work of the bureau has been systematized, so far as possible, and has required three distinct clerical forces to carry it on. All the clerical force of the bureau proper has been under the charge of Maj. Geo. H. Long, Deputy-Chief of the Bureau, who also had charge of the vast correspondence incident to the census; he has also conducted the preparation of this Report, in which work he was ably assisted by Mr. Oren W. Weaver, who also supervised the make-up of the book, and took charge of the proof-reading. Mr. Weaver also edited the volume containing the census system.

The tabulation of the Census and Industrial Statistics, as well as the work of the enumerators, has been under the direct oversight of the chief, with the valuable assistance of Mr. Charles F. Pidgin, who has looked after the details of tabulations, inventing ingenious methods for rapid work, and saving much time and expense by the novel systems for counting which he has produced. Mr. Pidgin also prepared the matter for the Appendix to this volume.

The clerical force for the census tabulations, consisting of ladies, has been under the charge of Miss Lizzie M. Davis, Mrs. Lucy T. Barton, Mrs. Lucy S. Pidgin and Miss L. J. Sanderson, at 31 and 34 Pemberton Square; while the force consisting of gentlemen, engaged on the tabulation of returns of manufactures and agriculture, libraries, etc., has been under the direction first of Capt. Chas. W. Thompson, and then of Mr. T. Harrington, at 35 Pemberton Square. The

total clerical force, distributed in rooms which an inspector of factories ought to condemn, has been sixty-eight.

The field-work of the census was facilitated by the supervision of Messrs. Frank T. Richardson, John Carruthers, George C. Clapp, James Thomas, John Morissey and Henry O. Reed. These gentlemen aided the office very much in securing accurate returns through the assistance they were able to give the enumerators, and in various ways expediting the work with their presence.

To all the parties mentioned above, too much credit can not be given; their faithfulness, industry and zeal, with the conscientious discharge of duty by the force of enumerators and by the clerical force, have been to the officers of the bureau wonderful compensation for the manifold obstacles which have met them at every stage of their labors; this, in connection with the perfect success of the system, in all respects completely shuts out of view the thorny road they have travelled for many months.

The report for 1876 is unavoidably late on account of the special work which has been contemporaneous with it.

Census Results.

It is deemed appropriate, in this part of the Report, to state a few results, of value to those most interested in the work of the bureau, derived from the census of 1875.

The population of Massachusetts is: males, 794,383; females, 857,529 (an excess of 63,146); total, 1,651,912; and they are employed as follows:—

Occupations of Massachusetts.

CLASSES.	Males.	Females.	Total.
I. Government and professional, .	19,142	10,669	29,811
II. Domestic and personal office, .	11,292	412,993	424,285
III. Commercial and transportation,	101,386	3,549	104,935
IV. Agricultural products, stock raisers and fisheries, . .	81,119	37	81,156
V. Art and mechanic productions,	233,252	83,207	316,459
VI. Indefinite, non-productive and propertied, ...	62,169	3,261	65,430
VII. Unemployed (not including scholars and students), . .	143,242	203,810	347,052
VIII. Scholars and students, . .	142,781	140,003	282,784
	794,383	857,529	1,651,912

The census shows a population to the square mile of 211.78 persons. In 1865, there were 162.43 persons; and in 1870, 186.84 persons to that area.

The average size of family is established as being 4.6 persons. In 1865, it was 4.69; in 1870, 4.77.

The occupied dwelling-houses in the State contain, on an average, 6.46 persons. If all the houses in the State were occupied, the average number of persons to each would be 6.18. In 1865, the average for each dwelling-house was 6.07; in 1870, 6.16.

Of the male population of the State, 44+ per cent are legal voters, and 56+ per cent ratable polls. The naturalized voters compose 19.7 per cent of the whole number. The aliens, meaning persons over 21 years of age, of foreign birth, who have not become citizens, number 79,126.

The total number of illiterates in the State, is, in round numbers, 103,000, about 8½ per cent of this number being natives.

The number of establishments engaged in manufacturing, or in occupations allied to manufactures, is 22,371. The United States census for 1870 reported the number as 13,212. The State census of 1865 returned 13,055 such establishments.

The Future of the Bureau.

We are already engaged upon work for the report of 1877. Much of the next report will be made up from important facts contained in the various schedules of the census series now in our possession. These points hardly have a place in the volumes devoted to the census abstracts; but are of great importance so far as social science is concerned. With these points, and the results of our investigations relative to arbitration, etc., the report of 1877 must be of great value.

We can not refrain from urging upon the legislature the necessity of bringing under one organization the gathering and preparation of all statistics relating in any way to the condition of the people. What now costs the State, annually, some seventy thousand dollars, could be done for less than twenty thousand.

As to more power for this bureau—the people have given it. When the introduction to the report for 1875 was written, the circumstances were entirely different from those existing to-day; then the manufacturers of the State were, to a considerable extent, afraid of the bureau, and, in some sense, inimical to it; to-day, they are, as a rule, its friends. The people have learned, through the liberal advertising of those who deem the existence of this office not essential, the good it can do, and of its efforts to labor for the best interests of the Commonwealth; so that now, through the success of the past year, all question of the future usefulness of the bureau should be settled, and we prophecy for it, under any candid management, the support of the people. The work of the bureau is educational in its character, and therefore silent. It needed the test of the work of the past year to demonstrate its power for action; and that power having been developed, should be used in the highest sense for the improvement of the masses.

Personal.

This introduction should not be closed without particular recognition of the services of Major Geo. H. Long, who, till the 31st of March, 1876, had been, since June, 1873, the deputy-chief of the bureau. A co-laborer with the chief in all the duties of the office, and an earnest worker in all the

various plans of the bureau, he has won the regard and warm esteem of all connected with it. By the invitation of the Commissioner of Insurance for Massachusetts, Major Long has taken the position of Deputy Insurance Commissioner, and while this office loses a valuable officer, the State still retains his services and will profit by his experience.

Part I.

WAGE RECEIVERS.

Chap. I.—Occupations and Presentation by Schedule Questions.

Chap. II.—Presentation by Counties and Exhibit of Averages.

Chap. III.—Family Presentation.

Chap. IV.—Presentation of Special Cities and Towns, and Exhibit of Averages.

Chap. V.—Presentation of Twenty Important Occupations, and Exhibit of Averages.

Part I.

WAGE RECEIVERS.

CHAPTER I.

Occupations and Presentation by Schedule Questions.

One of the first difficulties that presented itself to us was the separation of what are known as salary receivers from the larger class known as wage receivers.

In the few particular instances that any one can call to mind of the class of hired workers among his personal acquaintances, it is usually an easy matter to determine in each case whether the person is one who would be generally recognized as a salary receiver or a wage receiver. For it somehow happens that one's acquaintances do not seem to adopt exceptional employments as a means of obtaining a livelihood. They are usually clerks, carpenters, tailors, officers of corporations, common laborers, etc. But when nearly a hundred thousand persons throughout a great Commonwealth like ours, representing such various employments that they become an epitome of the civilization of the world's nineteenth century, are to be considered, it becomes a difficult matter to determine to which class certain employments belong. Moreover, there are a great many occupations which represent both wage and salary receivers. The salesman who is hired at a round salary of three thousand a year, and is allowed his month's vacation at midsummer, and an occasional day at other times, without a pro rata deduction from his pay, which he draws in twelve equal portions during the year, and his brother who works for eight dollars a

Saturday night, if he has been absent one-half of one of the six preceding days, represent the same occupation.

So that it seemed to become necessary, in the assortment and tabulation of such a vast number of schedules, representing the multifarious industries of the State, that a more or less arbitrary line should be drawn in the consideration of this or that particular schedule, and it should be said: this shall be held to represent a salary receiver; that, a wage receiver.

The plan that was adopted was, in the case of the ordinary trades, or handicrafts, to consider all as wage receivers unless the rate of pay was so exceptionally high as to indicate exceptional skill, and make it probable that such exceptional favors to the worker might follow, in the way of vacations, etc., as to elevate it substantially to a salaried occupation for him.

Among handicrafts, and the avocations involving manual labor, when the pay received has amounted to more than ten or eleven hundred dollars per year, they have generally been classed and tabulated as salaried; otherwise, as wage. Yet, here and there, where there was evidence that justified it, persons receiving twelve and even fifteen hundred dollars a year, have been included among wage receivers. Such cases have been rare, however, and not sufficiently numerous to affect the results materially.

On the other hand, many persons who receive comparatively low rates of pay for their services have been included among salary receivers. Such is the case in those avocations which are not supposed to involve much manual labor, and in those in which the use of the craftsman's tools is not needed; as salesmen, clerks and teachers of all grades.

It will be seen, then, from what we have said, that persons pursuing the same occupation, in some cases have been tabulated as wage receivers; in others, as salary receivers.

To recapitulate: occupations involving chiefly mental and literary qualifications are considered as salaried; those involving manual labor and skill in the use of tools, as wage; there being some exceptions in each case, those in the latter being where the rate of pay is exceptionally high.

Following will be found a list of the occupations represented by all the persons in the State, working for wages, who answered even one question of the seventeen asked on the Individual Schedules. About 950 different occupations are enumerated, representing the employments of the 71,339 persons working for wages from whom we received schedules.

Some of the occupations mentioned are followed by but very few persons, while others are pursued by vast numbers.

One important point must be borne in mind in the examination of the tables which follow; that is, that in some of these avocations board is given in addition to wages. Such is the case in respect to domestic servants, cooks, housekeepers, waiters, nurses, mariners, and stewards. It is often the case with laundresses, seamstresses, and dressmakers; with the latter it is especially apt to be the case in rural districts. Coachmen, also, usually get board, and oftentimes lodging. With these few preliminary words, we present the following list of occupations, and the showing by schedule questions for all counties and for the State.

Occupations of Wage Workers from whom Schedules were Received.

Agricultural implement maker.
Anchor smith.
Annealer of iron.
Armorer.
Artificial limb maker.
Artificial stone worker.
Atomizer maker.
Awl grinder.
Awl maker.
Axe grinder.
Axe helve maker.
Baker.
Barber.
Bartender.
Basket maker.
Base ball maker.
Batting maker.
Bedstead maker.
Beer maker.
Bell-hanger.
Belt lacing maker.
Belt maker.
Billiard ball maker.
Billiard cushion maker.
Billiard table maker.
Bill collector.
Bill poster.
Bird-cage maker.
Bit and gimlet maker:
  Filer.
  Forger.
  Grinder.
  Twister.
Blacking maker.
Blacksmith.
Bleachery factory operative:
  Bleacher.
  Drier.
  Finisher.
  Presser.
  Starcher.
Block cutter.

Boat builder.
Boatman.
Bobbin maker.
Boiler maker.
Bolt cutter.
Bolt header.
Bolt maker.
Book agent.
Bookbinder.
Book cutter.
Book folder.
Book gilder.
Book sewer.
Boot tree maker.
Bottler.
Box fitter.
Box maker.
Box nailer.
Braid factory operative
    Overseer.
Brass and copper tube m
Brass finisher.
Brass moulder.
Brass turner.
Brass worker.
Brewer.
Brick maker.
Brick mason.
Bridge builder.
Bridge tender.
Britannia ware maker:
    Spinner.
Bronzer.
Broom maker.
Brush maker.
Busheller.
Butcher.
Butler.
Butter maker.
Button maker.
Cab maker.
Cabinet-maker.
Cable wire maker.
Calker.
Candy packer.
Cap maker.
Car builder.

Clock maker.
Cloth clipper.
Clothing trimmer.
Coachman.
Coal heaver.
Coal oil maker.
Coffee roaster.
Coffin maker.
Collar maker.
Collier.
Comb maker:
- Bender.
- Engraver.
- Finisher.
- Packer.
- Shaver.

Common laborer.
Companion.
Compass maker.
Concrete roofer.
Concrete walk maker.
Confectioner.
Cook.
Cooper.
Coppersmith.
Copper stamp maker.
Copyist.
Copy reader.
Cork cutter.
Cornice maker.
Corset maker:
- Cutter.
- Finisher.
- Lacing braider.
- Presser.
- Stitcher.

Cotton factory operative:
- Beamer.
- Braider.
- Carder.
- Card grinder.
- Card stripper.
- Cloth finisher.
- Cloth inspector.
- Cloth marker.
- Dresser.
- Dyer.
- Folder.
- Filling assorter.

Cotton factory operative—*Con.*
- Lapper tender.
- Loom fixer.
- Mule spinner.
- Packer.
- Picker tender.
- Quiller.
- Section hand.
- Slasher tender.
- Speeder tender.
- Spinner.
- Spooler.
- Trimmer.
- Twister.
- Warper.
- Weaver.
- Web drawer.
- Winder.

Cotton sampler.
Cotton waste cleaner.
Crutch maker.
Currier:
- Beamster.
- Dresser.
- Finisher.
- Measurer.
- Scourer.
- Splitter.
- Stuffer.
- Tableman.

Curtain fixture maker.
Cutler:
- Blade cutter.
- Blade oiler.
- Bolster dropper.
- Cleaner.
- Finisher.
- Forger.
- Grinder.
- Hafter.
- Hammersman.
- Handle sawyer.
- Inspector.
- Packer.
- Polisher.
- Riveter.
- Temperer.
- Trimmer.

Deck hand.

Decorator.
Designer on wood.
Diary case maker.
Die cutter.
Die sinker.
Distiller.
Domestic servant.
Dressmaker.
Drain pipe maker.
Draughtsman.
Dredger.
Driver (ice, grocery and other wagons).
Drum maker (military and toy).
Dye house operative.
Earthen ware maker.
Edge tool maker:
  Finisher.
  Forger.
  Grinder.
  Temperer.
Elastic goods maker.
Electro-plater.
Electrician.
Electrotyper.
Electrotype finisher.
Emery maker.
Emery wheel maker.
Engineer (marine).
Engineer (stationary).
Engineer (steam fire).
Engraver (gold and silver).
Engraver (plate).
Engraver (steel).
Engraver (stone).
Engraver (wood).
Envelope cutter.
Envelope maker.
Expressman.
Eyelet maker.
Fan maker.
Fan polisher.
Fancy trimmings maker.
Farm laborer.
Faucet maker.
Ferryman.
File maker:
  Cutter.
  Forger.
File maker—*Con.*
  Grinder.
  Layer.
Fireman (Marine).
Fireman (stationary).
Fireman (steam fire engine).
Fish drier.
Fisherman.
Fish packer.
Flour inspector.
Founderyman:
  Assorter.
  Core maker.
  Dresser.
  Foreman.
  Furnace man.
  Grinder.
  Heater.
  Helper.
  Hollow-ware dresser.
  Iron polisher.
  Melter.
  Moulder.
  Puddler.
  Stove mounter.
Frame maker.
Fur cutter.
Fur dresser.
Fur sewer.
Fur tanner.
Furnace builder.
Furniture maker:
  Finisher.
  Repairer.
  Trimmer.
  Varnisher.
Gardener.
Gas meter maker.
Gilder.
Glass factory operative:
  Blower.
  Burnisher.
  Cutter.
  Designer.
  Engraver.
  Flattener.
  Ornamenter.
  Packer.
  Polisher.

Glass factory operative—*Con.*
- Presser.
- Shearer.
- Stoppleman.

Glazier.
Gold beater.
Gold chain maker.
Gold leaf cutter.
Governess.
Grinder of ochre.
Grist mill operative.
Gunny cloth weaver.
Gunpowder maker.
Gunsmith.
Hackman.
Hair picker.
Hair weaver.
Hair worker.
Hame maker.
Harness cleaner.
Harness maker.
Hatter:
- Binder.
- Bleacher.
- Hardener
- Finisher.
- Presser.
- Washer.

Hay rake maker.
Herb assorter.
Herb presser.
Hoe maker.
Hod-carrier.
Hoop maker.
Hoop-skirt maker.
Horn jewellery maker.
Horn worker.
Horse boot maker.
Horse clipper.
Horse clothing cutter.
Horse collar maker.
Horse nail maker.
Horse trainer.
Horse shoer.
Hose carriage driver.
Hose maker.
Hosiery mill operative:
- Cutter.
- Finisher.

Hosiery mill operative—*Con.*
- Folder.
- Knitter.
- Mender.
- Presser.
- Roller.
- Spinner.
- Stitcher.
- Trimmer.
- Weaver.
- Winder.

Hostler.
Housekeeper.
Ice tool maker.
Instrument maker.
Iron worker:
- Fireman.
- Forger.
- Hammersman.
- Rail cutter.
- Rivet maker.
- Roller.
- Scaler.
- Shingler.
- Steel cutter.

Ivory worker.
Janitor.
Japanner.
Jeweller.
Jewellery case maker.
Jeweller's basket maker.
Jewellery maker:
- Chaser.
- Foreman.
- Polisher.

Junk gatherer.
Junk assorter.
Label packer.
Lace maker.
Ladder maker.
Lamplighter.
Lamp maker.
Lantern maker.
Last maker.
Lather.
Laundress.
Laundryman.
Lead caster.
Leather assorter.

Leather board finisher.
Leather cutter.
Leather japanner.
Lime burner.
Linseed oil maker.
Lithographer.
Lithographer (chromo).
Locksmith.
Lock polisher.
Longshoreman.
Loom harness maker.
Lumberman.
Lumber mill operative:
  Jointer.
  Planer.
  Sawyer.
Machinist.
Machine knitter.
Malt maker.
Marble worker:
  Finisher.
  Foreman.
  Polisher.
Mariner.
Marketman.
Mason.
Mast and spar maker.
Match maker.
Mathematical instrument maker
Mat maker.
Mattress maker.
Mechanic.
Messenger.
Metal moulding maker.
Milkman.
Miller.
Millwright.
Milliner.
Miner.
Morocco dresser:
  Finisher.
  Shaver.
Moulding maker.
Musician.
Nail maker:
  Feeder.
  Gauger.
Neck stock maker.
Necktie maker.

Needle book maker.
Needle grinder.
Needle maker.
Nurse.
Nurseryman.
Oar maker.
Oil factory laborer.
Organ factory operative:
  Action maker.
  Bellows maker.
  Case maker.
  Finisher.
  Key board maker.
  Key maker.
  Key polisher.
  Pipe maker.
  Reed board maker.
  Reed maker.
  Shaft maker.
  Spring maker.
  Stop maker.
  Tuner.
Oysterman.
Oyster opener.
Packer (of merchandise).
Painter (house).
Painter (ornamental).
Paint grinder.
Paint maker.
Palm leaf worker:
  Hat maker.
  Hat finisher.
  Hat packer.
  Hat presser.
  Hat stamper.
Paper-mill operative:
  Assorter.
  Bleacher.
  Boiler tender.
  Calenderer.
  Counter.
  Cutter tender.
  Dyer.
  Finisher.
  Folder.
  Foreman.
  Machine tender
  Packer.
  Pulp maker.

Paper-mill operative—*Con.*
- Rag cutter.
- Ruler.
- Sealer.
- Size maker.

Paper bag maker.
Paper box maker.
Paper collar maker.
Paper hanger.
Paper stamper.
Paper stainer.
Pattern maker.
Paver.
Pedler (of various kinds).
Peg machine operator.
Perfumery maker.
Photographist.
Photograph printer.
Piano maker:
- Action maker.
- Case maker.
- Finisher.
- Key fitter.
- Plate driller.
- Polisher.
- Regulator.
- Sounding-board maker.
- Stringer.
- Top maker.
- Trimmer.
- Tuner.
- Varnisher.
- Veneerer.

Piano mover.
Picture frame gilder.
Picture frame maker.
Picture frame varnisher.
Pile driver.
Pin maker.
Pipe layer.
Pipe works operative:
- Carriage runner.
- Pipe cutter.

Pistol maker.
Plane maker.
Planing-mill operative.
Plaster block maker.
Plasterer.
Plumber.
Policeman.
Polisher.
Pop-corn maker.
Pork packer.
Porter.
Potter.
Poultry dresser.
Powder keg maker.
Printer:
- Compositor.
- Foreman.
- Press feeder.
- Pressman.

Print works operative:
- Calenderer.
- Calico finisher.
- Calico printer.

Proof reader.
Pump maker.
Quarryman.
Railroad employés (steam):
- Baggage master.
- Brakeman.
- Car inspector.
- Check man.
- Engineer.
- Engine wiper.
- Flag man.
- Fireman.
- Freight agent.
- Freight conductor.
- Freight master.
- Gate tender.
- Laborer.
- Section master.
- Signal tender.
- Station agent.
- Switchman.
- Trackman.
- Watchman.

Railroad employés (horse):
- Conductor.
- Driver.

Rake maker.
Rattan worker:
- Basket weaver.
- Chair maker.
- Shaver.
- Sizer.

Rattan worker—*Con.*
- Spinner.
- Splitter.
- Washer.
- Weaver.

Razor strop maker.
Reed maker.
Reed and heddle maker.
Reporter.
Rigger.
Road surveyor.
Roofer.
Rope maker.
Rope factory operative:
- Hemp dresser.
- Spinner.

Rubber factory operative.
Saddler.
Safe maker.
Sailmaker.
Sash, door and blind maker.
Sausage maker.
Saw maker.
Saw filer.
Saw setter.
Sawyer.
Scale maker.
Seamstress.
Seedsman.
Sewing-machine maker.
Sewing-machine needle maker.
Sewing-machine operator.
Sewing-machine repairer.
Sexton.
Ship fastener.
Ship keeper.
Shipper.
Shipsmith.
Shirt maker.
Shirt-front maker.
Shoddy maker.
Shoe-knife maker.
Shoe-string cutter.
Shoemaker:
- Beater out.
- Binder.
- Blacker.
- Blocker.
- Bottomer.

Shoemaker—*Con.*
- Buffer.
- Burnisher.
- Button-hole maker.
- Channeller.
- Clamper.
- Clicker.
- Closer.
- Corder.
- Counter maker.
- Crimper.
- Cutter.
- Dresser.
- Edge maker.
- Embosser.
- Eyeleter.
- Finisher.
- Fitter.
- Foreman.
- Gluer.
- Heeler.
- Inner sole maker.
- Inspector.
- Lacer.
- Laster.
- Leather assorter.
- Leveller.
- Machine operator.
- McKay machine operator.
- Nailer.
- Packer.
- Paster.
- Pegger.
- Pegging-machine operator.
- Riveter.
- Roller.
- Rosette maker.
- Sand paperer.
- Seam rubber.
- Shank presser.
- Shaver.
- Sider.
- Skiver.
- Slipper liner.
- Sole assorter.
- Sole leather cutter.
- Sole quilter.
- Stamper.
- Stiffener.

Shoemaker—*Con.*
- Stitcher.
- Stock fitter.
- Stringer.
- Stripper.
- Tagger.
- Tip maker.
- Treer.
- Trimmer.
- Turner.
- Vamper.
- Welter.

Shoe-shank maker.
Shovel factory operative:
- Hammersman.
- Handler.
- Heater.
- Polisher.
- Setter.
- Welder.

Show-case maker.
Shuttle maker.
Sieve maker.
Silk mill operative:
- Spooler.
- Weaver.
- Winder.

Silver and nickel plater.
Silversmith.
Slater.
Sleigh maker.
Soap maker.
Soap stamper.
Soapstone worker.
Soda fountain maker.
Soda maker.
Spectacle maker:
- Filer.
- Finisher.
- Jointer.
- Polisher.

Spindle grinder.
Spindle maker.
Spoke driver.
Spoke maker.
Spoon maker.
Spring bed maker.
Spring maker.
Stage driver.
Stair builder.
Stamp maker.
Starch maker.
Steam and gas fitter.
Steam fire engine driver.
Steel letter cutter.
Steel melter.
Steel polisher.
Stencil cutter.
Stereotype caster.
Stereotype finisher.
Stereoscope maker.
Stevedore.
Steward.
Stone cutter.
Stone-grinder.
Stone mason.
Straw factory operative:
- Bleacher.
- Blocker.
- Bonnet maker.
- Braid measurer.
- Dyer.
- Finisher.
- Frame maker.
- Machine operator
- Overseer.
- Packer.
- Presser.
- Sewer.
- Shaper.
- Sizer.
- Trimmer.
- Weaver.
- Wirer.

Street waterer.
Stucco worker.
Sub-marine diver.
Sugar-house laborer:
- Boiler.
- Refiner.

Surveyor.
Suspender maker.
Sword maker.
Tack factory operative:
- Foreman.
- Header.
- Japanner.
- Machine tender.

Tack factory operative—*Con.*
Maker.
Marker.
Overseer.
Packer.
Plate slitter.
Shoe nail cutter.
Tailor:
Cutter.
Pressman.
Trimmer.
Tailoress.
Tanner.
Tape factory operative.
Tassel maker.
Teamster.
Telegraph operator.
Telegraph repairer.
Thread mill operative:
Dresser.
Dyer.
Twister.
Warper.
Winder.
Timekeeper.
Tinsmith.
Tobacco stripper.
Tollman.
Tool maker.
Tortoise-shell worker.
Toymaker.
Tripe dresser.
Truckman.
Trunk maker.
Trunk wood fitter.
Truss maker.
Twine maker.
Twine netter.
Twist drill maker.
Type caster.
Umbrella maker.
Undertaker.
Upholsterer.
Varnisher.
Varnish maker.
Vinegar maker.
Waiter.
Wallet maker.
Watch factory operative:
Case maker.
Engraver.
Finisher.
Gilder.
Hair spring maker.
Key maker.
Pallet maker.
Plater.
Polisher.
Screw maker.
Turner.
Wheel maker.
Watchman.
Water pipe layer.
Well digger.
Wharfinger.
Wheel maker.
Wheelwright.
Whip maker:
Buttoner.
Mounter.
Plaiter.
Whitener.
Whitewasher.
Window shade maker.
Wire factory operative:
Annealer.
Cleaner.
Cooler.
Drawer.
Finisher.
Plater.
Pointer.
Straightener.
Temperer.
Weaver.
Willow ware maker.
Wood chopper.
Wood dyer.
Wood polisher.
Wood worker.
Wooden box maker.
Wooden ware maker.
Woollen factory operative:
Assorter.
Burler.
Card cleaner.

Woollen factory operative—*Con.*
- Carder.
- Colorer.
- Comber.
- Drawer in.
- Dresser.
- Drum tender.
- Dyer.
- Felter.
- Finisher.
- Foreman.
- Fuller.
- Gigger.
- Jack spinner.
- Loom fixer.
- Napper.
- Oiler.
- Overseer.
- Picker tender.
- Presser.
- Reeler.

Woollen factory operative—*Con.*
- Repairer.
- Scourer.
- Shawl fringer.
- Shearer.
- Specker.
- Spinner.
- Spooler.
- Stitcher.
- Teasel setter.
- Twister.
- Warper.
- Weaver.

Woollen felt factory operative:
- Carder.
- Finisher.
- Fuller.
- Hardener.

Worsted worker.
Wreath maker.
Yeast maker.

Presentation by Schedule Questions.

In the succeeding pages, a tabulated presentation is made, by counties, showing five points for each sex, with reference to each of the seventeen questions asked in the schedule. Firstly, the whole number of schedules returned from the county. Secondly, the whole number of persons answering. Thirdly, the percentage of the number answering to the whole number of schedules. Fourthly, the aggregate for all persons answering. Fifthly, the average for each person answering. Two facts are to be borne in mind by the reader in examining, not only the tables in this chapter, but those that follow in Part II.

No person could answer all the questions asked in the schedule; for some of them were of such a nature that an answer in one case would serve to render another question inapplicable. If a person replied that they owned the house they lived in, the inquiry as to the number of rooms hired would not be pertinent, or *vice versa;* and so of some other questions.

Very many persons did not answer all the questions which were applicable, and which they probably could have an-

swered, and would have answered, had a little more pressure been brought to bear upon them. Some persons answered but a single question; as, perhaps, the number of hours per day employed in their occupation, or the sum received as a daily wage, or the salary per year. Others gave replies to two, three, four, or more inquiries.

Throughout the tables in this Part, as well as in Part II., where the per cent is less than *one*, it is not computed. This course was adopted to avoid the necessity of introducing a third column, which would be a column of tenths of one per cent. The basis of computation is, however, always at hand, and any one desiring greater exactness can reckon it for himself. In the case of those computed, the per cent has been increased *one* when it was more than one-half.

In the column of averages the numbers are expressed in integers and decimals, the latter being carried out two places.

By page 16 it is seen that 1,231 schedules were received from *males* in Barnstable County, and that 788 answered *affirmatively* that they had *persons* (not specified whether minors or adults) dependent upon them for support, which is 64 per cent of the whole number who thus filled out schedules.

The aggregate of the persons dependent is 2,250, and the average for each male returning a schedule is 2.86. On the succeeding page, a similar exhibit is made respecting the question, as shown by the schedules received from *females*. This explanation seems all that is needed to make the following tables clear to every one.

It may be added, however, that the most suggestive words only of each inquiry are used as head lines to precede each table.

Presentation by Schedule Questions.

[Note.—A full explanation of the abbreviated form of question used as the head line of each table, can be found in the introduction. For a presentation similar to this, respecting *salaried* persons, see Part II. The facts presented in these tables refer to *wage* laborers.]

Persons Dependent on Males.

Counties.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . .	1,231	788	64	2,250	2.86
Berkshire, . .	2,143	1,522	71	5,164	3.39
Bristol, . . .	3,147	2,189	69	6,868	3.13
Dukes, . . .	215	175	81	635	3.63
Essex, . . .	6,277	4,578	73	13,556	2.96
Franklin, . .	1,329	964	72	2,886	2.99
Hampden, . .	3,575	2,692	75	8,156	3.03
Hampshire, . .	910	661	73	2,051	3.10
Middlesex, . .	11,188	8,220	73	25,581	3.11
Nantucket, . .	11	10	91	20	2.00
Norfolk, . . .	4,180	3,154	75	10,054	3.18
Plymouth, . .	4,524	3,241	72	9,927	3.06
Suffolk, . . .	5,921	4,536	77	13,734	3.03
Worcester, . .	10,864	7,950	73	24,213	3.04
For the State, .	55,515	40,680	73	125,095	3.08

By referring to the tables of dependence among salaried persons to be found in Part II., it will be seen that 68 per cent answered as to this question.

It will be seen above that 73 per cent of the wage receivers make reply, or five per cent more than of salary receivers. This of course indicates a larger number of people in a condition to answer. Or, in other words, as wives and children constitute the mass of dependents, that there are more wage

Persons Dependent on Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable, . .	134	24	18	41	1.71
Berkshire, . .	510	74	14	168	2.27
Bristol, . . .	1,137	136	12	263	1.93
Dukes, . . .	9	2	22	3	1.50
Essex, . . .	1,771	200	11	389	1.95
Franklin, . .	291	31	11	54	1.74
Hampden, . .	1,156	114	10	195	1.71
Hampshire, . .	269	16	6	25	1.56
Middlesex, . .	4,215	484	11	777	1.60
Nantucket, . .	12	3	25	3	1.00
Norfolk, . . .	665	90	14	163	1.81
Plymouth, . .	615	65	10	136	2.09
Suffolk, . . .	2,756	348	13	629	1.81
Worcester, . .	2,284	196	9	324	1.65
For the State, .	15,824	1,783	11	3,170	1.78

receivers, with wife or child, than of salary receivers. The numbers of each class considered are sufficiently large to make the percentages reliable, and indicative of exactly that condition. So that marriage is more general among the wage class than in the class next above them in the means of supporting families.

Turning now to the "average for each person answering," and it is found that among the wage receivers there are 3.08 persons dependent on each one answering, while (Part II.) there are 2.64 dependent on each salaried person answering. The number of dependent, then, on each, among wage receivers, is about 17 per cent more than among salary receivers. And as most of the dependents are children, fecundity must be

Hours Employed—Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable,	1,231	738	60	7,955	10.78
Berkshire,	2,143	2,059	96	21,298	10.35
Bristol,	3,147	3,029	96	30,714	10.14
Dukes,	215	177	82	1,817	10.26
Essex,	6,277	6,061	97	61,990	10.23
Franklin,	1,329	1,270	96	13,346	10.51
Hampden,	3,575	3,541	99	35,251	9.95
Hampshire,	910	894	98	8,720	9.75
Middlesex,	11,188	10,971	98	112,894	10.29
Nantucket,	11	11	100	107	9.73
Norfolk,	4,180	3,964	95	40,194	10.14
Plymouth,	4,524	4,349	96	43,329	9.96
Suffolk,	5,921	5,601	95	57,960	10.35
Worcester,	10,864	10,639	98	108,717	10.22
For the State,	55,515	53,304	96	544,292	10.21

considerably greater among the wage class. So far, we have considered the *males* who have returned schedules. A comparison of the returns of dependence among *females*—the wage with the salaried—exhibits the same facts. Among the wage class, 11 per cent answer that they have persons dependent upon them. Among the salaried class (Part II.), only 8 per cent reply affirmatively. Among the wage class, the average number dependent on each person answering is 1.78. Among the salaried class (Part II.), it is 1.63.

The tabulation of the returns to the question, "Number of hours per day employed," seems to verify the old adage, that "Man's work is from sun to sun, while woman's work is never done." Ninety-six per cent of the schedules returned by

Hours Employed—Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable, . .	134	114	85	1,194	10.47
Berkshire, . . .	510	455	89	4,777	10.49
Bristol, . . .	1,137	947	83	9,713	10.26
Dukes, . . .	9	9	100	82	9.11
Essex, . . .	1,771	1,569	89	16,079	10.25
Franklin, . . .	291	266	91	2,790	10.49
Hampden, . . .	1,156	1,090	94	11,872	10.89
Hampshire, . .	269	246	91	2,561	10.41
Middlesex, . . .	4,215	3,787	90	39,534	10.44
Nantucket, . . .	12	12	100	120	10.00
Norfolk, . . .	665	562	85	5,893	10.49
Plymouth, . . .	615	492	80	4,841	9.84
Suffolk, . . .	2,756	1,922	70	21,266	11.06
Worcester, . . .	2,284	2,036	89	20,957	10.29
For the State, . .	15,824	13,507	85	141,679	10.49

males were filled out as to this inquiry; while only 85 per cent of those returned by females were filled out. Among the wage occupations of the latter sex, that of domestic service is the most common, and as it is a species of employment that is "never done," this question was quite commonly unanswered by females so employed. The average number of hours employed, for males, is shown to be 10.21; and for females, 10.49. The average for salaried persons (Part II.) is seen to be 10.41 for males, and 6.34 for females. The average per day, for males, is largest in Barnstable County, and smallest in Hampshire; for females, it is largest in Suffolk, and smallest in Plymouth. Among salaried males (Part II.), it is found to be largest in Barnstable, and smallest

Days Employed—Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable,	1,231	931	76	208,693	224.16
Berkshire,	2,143	1,842	86	456,684	247.93
Bristol,	3,147	2,678	85	600,663	224.29
Dukes,	215	182	85	34,239	188.13
Essex,	6,277	5,378	86	1,275,689	237.20
Franklin,	1,329	1,144	86	283,107	247.47
Hampden,	3,575	3,406	95	851,050	249.87
Hampshire,	910	813	89	195,947	241.02
Middlesex,	11,188	9,913	89	2,392,279	241.33
Nantucket,	11	11	100	2,763	251.18
Norfolk,	4,180	3,697	88	830,301	224.59
Plymouth,	4,524	4,050	89	832,176	205.48
Suffolk,	5,921	5,318	89	1,341,231	252.21
Worcester,	10,864	8,418	77	2,241,234	266.24
For the State,	55,515	47,781	86	11,546,056	241.65

in Franklin; among females, the largest in Suffolk, and smallest in Berkshire. Thus it is the largest, for males, for both wage and salaried workers in Barnstable; and the largest, for females, of both classes in Suffolk.

The inquiry as to the "Number of days employed in your occupation during the year," was a very important one, and the number of answers obtained make the averages deduced of the highest value. Forty-seven thousand seven hundred and eighty-one males, out of 55,515, replied to this question; and 13,997 females, out of 15,824, replied, or a total of 61,778 persons, out of 71,339.

The largest percentage of replies was from Hampden County, 95 per cent of the schedules containing answers to

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable, . .	134	122	91	24,997	204.89
Berkshire, . .	510	[illegible]	91	123,339	266.39
Bristol, . . .	1,137	1,005	88	258,708	257.42
Dukes, . . .	9	8	89	1,480	185.00
Essex, . . .	1,771	1,511	85	389,211	257.58
Franklin, . .	291	251	86	64,469	256.85
Hampden, . .	1,156	1,088	94	187,961	172.78
Hampshire, . .	269	237	88	61,821	[illegible]
Middlesex, . .	4,215	3,778	89	1,022,194	270.56
Nantucket, . .	12	12	100	3,050	254.17
Norfolk, . . .	[illegible]	566	85	134,405	237.46
Plymouth, . .	615	[illegible]	83	119,429	235.09
Suffolk, . . .	2,756	2,398	87	715,356	298.31
Worcester, . .	2,284	2,050	90	518,175	252.77
For the State, .	15,824	13,997	88	3,624,615	258.96

this question. Nantucket, of course, is excepted, as the number of schedules received was too small to be of any value in arriving at a percentage or an average. The average number of days worked by males throughout the State is shown to be 241.65; by females, 258.96. The average among salaried persons (Part II.) is shown to be for males, 290.29; for females, 192.37. The highest average is in Worcester County, 266.24; but Suffolk, Hampden, Franklin and Berkshire are above the average.

The working year is seen to be the shortest in Dukes County, where the average is but 188.13 days. After Dukes comes Plymouth, 205.48; Barnstable, 224.16; Bristol, 224.29; and Norfolk, 224.59. The remaining counties vary

Daily Wages—Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . .	1,231	853	69	$1,619 19	$1 89
Berkshire, . .	2,143	1,786	83	3,166 72	1 77
Bristol, . . .	3,147	2,705	86	5,548 01	2 05
Dukes, . . .	215	174	81	360 07	2 07
Essex, . . .	6,277	5,215	83	10,238 08	1 96
Franklin, . .	1,329	1,230	93	2,241 16	1 82
Hampden, . .	3,575	2,873	80	5,271 26	1 83
Hampshire, . .	910	816	90	1,460 36	1 79
Middlesex, . .	11,188	10,076	90	20,730 05	2 06
Nantucket, . .	11	8	73	11 75	1 47
Norfolk, . . .	4,180	3,789	91	7,072 90	1 87
Plymouth, . .	4,524	4,033	89	8,107 87	2 01
Suffolk, . . .	5,921	5,304	89	12,137 99	2 29
Worcester, . .	10,864	9,885	91	19,860 88	2 00
For the State, .	55,515	48,747	88	97,826 29	2 01

but slightly from the state average. As there are 308 legal working days in the year, it will be seen that there is an amount of time lost for each male workman equal to a fraction more than 66 days. This is an important fact to be considered in any speculations upon the wage and capital problem. By reference to the Census and Industrial Statistics, the number of days in which establishments were open for work, as returned by manufacturers, can be seen. A comparison of the two will be found of value.

Forty-eight thousand seven hundred and forty-seven males have made reply as to the wages per day received by them, or 88 per cent of the whole number returning schedules. The average daily wage is found to be $2.01. Nearly or

Daily Wages—Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable, . .	134	121	90	$79 74	$0 66
Berkshire, . .	510	398	78	286 06	72
Bristol, . . .	1,137	947	83	887 36	94
Dukes, . . .	9	8	89	6 21	78
Essex, . . .	1,771	1,502	85	1,347 10	89
Franklin, . .	291	257	88	185 58	72
Hampden, . .	1,156	1,022	89	922 44	90
Hampshire, . .	269	243	90	189 53	78
Middlesex, . .	4,215	3,687	87	3,005 04	82
Nantucket, . .	12	9	75	3 96	44
Norfolk, . . .	665	491	74	415 01	85
Plymouth, . .	615	476	77	457 36	96
Suffolk, . . .	2,756	2,456	89	1,740 18	71
Worcester, . .	2,284	1,976	87	1,676 72	85
For the State, .	15,824	13,593	86	11,202 29	82

quite 900 occupations must be represented by the above number of persons. Certainly, here are a sufficient number of persons whose wages are aggregated to make the average obtained of such value as to be above criticism. We think it can be safely said, that the daily wage of the male adult workman in this Commonwealth, this year, is $2.01.

It may be held that there are included large numbers of persons in some occupations in which the wages are low, while but few in other employments which yield better renumeration are so included; or, the reverse of this may be supposed and maintained. But the probability is, that if one thousand schedules were sent in representing one occupation, and only one hundred representing another, it was

Yearly Wages—Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . .	1,231	974	79	$378,754 00	$388 86
Berkshire, . .	2,143	1,971	92	849,509 00	431 00
Bristol, . . .	3,147	2,769	88	1,262,809 00	456 05
Dukes, . . .	215	200	93	71,855 00	359 28
Essex, . . .	6,277	5,513	88	2,545,098 00	461 65
Franklin, . .	1,329	1,203	91	527,145 00	438 19
Hampden, . .	3,575	3,477	97	1,959,214 00	563 48
Hampshire, . .	910	830	91	338,650 00	408 01
Middlesex, . .	11,188	10,102	90	5,016,479 00	496 58
Nantucket, . .	11	11	100	3,605 00	327 73
Norfolk, . . .	4,180	3,824	91	1,710,016 00	447 18
Plymouth, . .	4,524	4,197	93	1,692,668 00	403 30
Suffolk, . . .	5,921	5,296	89	3,051,550 00	576 19
Worcester, . .	10,864	9,695	89	4,758,109 00	490 78
For the State, .	55,515	50,062	90	24,165,461 00	482 72

because there were ten times as many persons in the State following the former as the latter. Taking the State together, it is likely that about the same per cent of schedules was received from the representatives of all occupations. The average daily wage of females is seen to be 82 cents.

The daily wages, then, of women appear to be about two-fifths as much as those of men. Among salaried persons (Part II.), it will be seen they are over three-fifths as much. This difference between the relative earnings of the sexes, in the two classes, may be, and undoubtedly is, owing to the large number of wage schedules received from domestic servants, whose wages per day appear comparatively small, since their board, which is included, is an item of no small moment.

Yearly Wages—Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.
Barnstable, . .	134	114	85	$15,212 00
Berkshire, . .	510	490	96	87,908 00
Bristol, . . .	1,137	1,085	95	231,123 00
Dukes, . . .	9	9	100	1,846 00
Essex, . . .	1,771	1,541	87	327,029 00
Franklin, . .	291	266	91	47,544 00
Hampden, . .	1,156	1,106	96	242,870 00
Hampshire, . .	269	243	90	46,688 00
Middlesex, . .	4,215	3,906	93	801,662 00
Nantucket, . .	12	12	100	1,064 00
Norfolk, . . .	665	612	92	90,909 00
Plymouth, . .	615	579	94	105,457 00
Suffolk, . . .	2,756	2,567	93	507,944 00
Worcester, . .	2,284	2,129	93	406,794 00
For the State, .	15,824	14,659	93	2,913,550 00

Fifty thousand and sixty-two males, or 90 per cent, as to their yearly wages, and 14,659 females, or 93 pe The average yearly earnings of the former is found $482.72, and of the latter $198.76. The highest ave yearly earnings, for males, is found to be in Suffolk C $576.19. Hampden is nearly as high, while Middlese Worcester are both above the state average. The average (excepting Nantucket) is found in Dukes, $3 In Barnstable it was nearly as low, being but $388.86. rural counties show, generally, the lowest average, and possessing urban centres of importance the highest. Fe seem to be the best paid in Hampden, receiving an a

Other Earnings—Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . .	1,231	323	26	$25,731 00	$79 66
Berkshire, . .	2,143	152	7	17,133 00	112 72
Bristol, . . .	3,147	393	12	63,739 00	162 19
Dukes, . . .	215	77	36	6,989 00	90 77
Essex, . . .	6,277	683	11	79,776 00	116 80
Franklin, . . .	1,329	159	12	15,914 00	100 09
Hampden, . .	3,575	324	9	46,563 00	143 71
Hampshire, . .	910	100	11	8,789 00	87 89
Middlesex, . .	11,188	1,123	10	149,528 00	133 15
Nantucket, . .	11	4	36	165 00	41 25
Norfolk, . . .	4,180	597	14	65,493 00	109 70
Plymouth, . .	4,524	838	19	78,443 00	93 60
Suffolk, . . .	5,921	369	6	63,905 00	173 18
Worcester, . .	10,864	1,295	12	148,324 00	114 54
For the State, .	55,515	6,437	12	770,492 00	119 69

of $219.59; in Bristol, $213.02; in Essex, $212.22; and in Middlesex, $205.24.

In Bristol and Middlesex counties, the manufacture of cotton and woollen goods especially predominates; so also in Essex. This latter county is also the seat of the shoe manufacturing business.

The question, "Amount of other earnings," the replies to which are tabulated above, was expected to secure the sums earned in various ways before or after the regular day's labor at the regular employment had been done, or on days when no regular occupation was being pursued. The average, for males, in the State, is seen to be $119.69, a sum of considerable importance as an auxiliary in the support of a family,

Other Earnings—Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable,	134	17	13	$440 00	$25 88
Berkshire,	510	9	2	725 00	80 56
Bristol,	1,137	22	2	2,158 00	98 09
Dukes,	9	2	22	25 00	12 50
Essex,	1,771	33	2	2,527 00	76 58
Franklin,	291	6	2	273 00	45 50
Hampden,	1,156	23	2	1,249 00	54 30
Hampshire,	269	5	2	497 00	99 40
Middlesex,	4,215	80	2	6,539 00	18 74
Nantucket,	12	1	8	100 00	100 00
Norfolk,	665	32	5	2,219 00	69 34
Plymouth,	615	37	6	2,687 00	72 62
Suffolk,	2,756	52	2	5,927 00	113 98
Worcester,	2,284	97	4	7,123 00	73 43
For the State,	15,824	416	3	32,489 00	78 09

being about one-fourth as much as the regular yearly earnings; 12 per cent of all the males returning schedules had such earnings. Throwing out Dukes and Nantucket, Barnstable County returns the largest per cent of males having such earnings, and Suffolk County the smallest, being 26 per cent for the former, and 6 per cent for the latter. But the latter shows the highest average for each,—$173.18, and the former, the lowest,—$79.66.

By reference to the returns from salaried persons in Part II., it will be seen that the same counties made a corresponding exhibit in that class.

Children's Earnings Returned by Males.

COUNTIES.	No. of schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . .	1,231	157	13	$15,676 00	$99 85
Berkshire, . .	2,143	200	9	53,575 00	267 88
Bristol, . . .	3,147	295	9	98,979 00	335 52
Dukes, . . .	215	15	7	730 00	48 67
Essex, . . .	6,277	583	9	114,306 00	196 07
Franklin, . .	1,329	137	10	23,718 00	173 12
Hampden, . .	3,575	334	9	172,962 00	517 85
Hampshire, . .	910	74	8	13,611 00	183 93
Middlesex, . .	11,188	951	8	197,647 00	207 83
Nantucket, . .	11	-	-	-	-
Norfolk, . . .	4,180	448	11	89,237 00	199 19
Plymouth, . .	4,524	410	9	68,032 00	165 93
Suffolk, . . .	5,921	300	5	67,214 00	224 05
Worcester, . .	10,864	1,009	9	202,747 00	200 94
For the State, .	55,515	4,913	9	1,118,434 00	227 65

The average amount of minor children's earnings, for males, in the State, is $227.65, a sum nearly one-half as large as the fathers themselves earn at their regular occupations. It is to be borne in mind that this sum is not the average earnings of *each child*, but is the amount which accrues to *each father or mother* from the labor of a child or children. "Males" and "females" in the head line of the tables, refers in this case, as heretofore, to the sex of the persons returning the schedules, and not to the sex of the children. Only 9 per cent answer this question, so that the advantage obtainable from this source accrues to only a small portion of the wage workers of the State. It is, however, a great question

Children's Earnings Returned by Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable,	134	4	3	$187 00	$46 75
Berkshire,	510	9	2	2,924 00	324 89
Bristol,	1,137	5	-	1,223 00	244 60
Dukes,	9	1	11	50 00	50 00
Essex,	1,771	26	1	5,669 00	218 04
Franklin,	291	2	-	193 00	96 50
Hampden,	1,156	16	1	4,609 00	288 06
Hampshire,	269	1	-	150 00	150 00
Middlesex,	4,215	50	1	8,095 00	161 90
Nantucket,	12	-	-	-	-
Norfolk,	665	18	3	3,499 00	194 39
Plymouth,	615	8	1	1,679 00	209 88
Suffolk,	2,756	35	1	4,315 00	123 29
Worcester,	2,284	28	1	4,356 00	155 57
For the State,	15,824	203	1	36,949 00	182 01

whether the money brought into the family in this way subserves its best interests.

The children thus put into the factory and the workshop, are usually deprived of the school education necessary to their highest success in after-life. So that the real interests of the individual and of the State are thus sacrificed to the immediate demand for subsistence. It is a fact, that the most of the children working in mills, who furnish the large proportion of the earnings tabulated above, are growing up in ignorance. That they are the nucleus of a class that is likely to expand gradually into an element unfit for self-government, and unmanageable by the purblind intelligence that in

Unable to Work—Returned by Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . . .	1,231	25	2	26	1.04
Berkshire, . . .	2,143	31	1	32	1.03
Bristol, ...	3,147	80	3	121	1.51
Dukes, ...	215	5	2	6	1.20
Essex, ...	6,277	123	2	139	1.13
Franklin, . . .	1,329	29	2	33	1.14
Hampden, . . .	3,575	76	2	84	1.11
Hampshire, . . .	910	24	3	27	1.13
Middlesex, . . .	11,188	219	2	253	1.16
Nantucket, . . .	11	-	-	-	-
Norfolk, ...	4,180	82	2	94	1.15
Plymouth, . . .	4,524	115	3	130	1.13
Suffolk, ...	5,921	119	2	134	1.13
Worcester, . . .	10,864	257	2	290	1.13
For the State, . .	55,515	1,185	2	1,369	1.16

its haste to be rich has made use of their ignorance, there can be no doubt.

In connection with this subject, especial attention is called to Part IV., Chap IV. (page 354), of the last report of this Bureau, where will be found the results of an investigation, on a smaller scale, into the earnings of children. The exhibit there made is substantially corroborated by the more extensive examination of this year.

Only two per cent of males, and less than one per cent of females, made reply to the "Number of persons over eighteen years of age prevented by continuous sickness or physical disability from attending to any occupation." The males answering are seen to have an average of 1.16 persons

Unable to Work—Returned by Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable, . . .	134	4	3	5	1.25
Berkshire, . . .	510	1	-	1	1.00
Bristol, ...	1,137	2	-	2	1.00
Dukes, ...	9	-	-	-	-
Essex, ...	1,771	8	-	8	1.00
Franklin, . . .	291	-	-	-	-
Hampden, . . .	1,156	5	-	5	1.00
Hampshire, . . .	269	-	-	-	-
Middlesex, . . .	4,215	11	-	13	1.18
Nantucket, . . .	12	-	-	-	-
Norfolk, . . .	665	1	-	1	1.00
Plymouth, . . .	615	6	1	6	1.00
Suffolk, ...	2,756	13	-	14	1.07
Worcester, . . .	2,284	6	-	6	1.00
For the State, . .	15,824	57	-	61	1.07

dependent, by reason of mental or physical incapacity, on each; and the females an average of 1.07. Taking the schedules received from males and females together, it is found that for the whole 71,339 wage laborers there were 1,430 persons thus unable to work. This is an average of about one for every fifty individuals.

By referring to the returns from salaried workers in Part II., it will be seen that the average, in that class, varies but slightly from this.

Persons Owning Houses—Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . .	1,231	484	39	484	1.00
Berkshire, . . .	2,143	460	21	460	1.00
Bristol, . . .	3,147	546	17	546	1.00
Dukes, . . .	215	106	49	106	1.00
Essex, . . .	6,277	1,450	23	1,450	1.00
Franklin, . . .	1,329	372	28	372	1.00
Hampden, . . .	3,575	806	23	806	1.00
Hampshire, . .	910	247	27	247	1.00
Middlesex, . . .	11,188	2,648	24	2,648	1.00
Nantucket, . . .	11	7	64	7	1.00
Norfolk, . . .	4,180	1,318	32	1,318	1.00
Plymouth, . . .	4,524	1,587	35	1,587	1.00
Suffolk, . . .	5,921	622	11	622	1.00
Worcester, . . .	10,864	2,393	22	2,393	1.00
For the State, . .	55,515	13,046	23	13,046	1.00

In an examination into the condition of the working population of a state, there is no more important fact to be discovered than the proportion of people who possess, in fee simple, the houses which shelter them. No statement as to the occupations, earnings, expenses, etc., is of much value that is not accompanied with the facts relating to this point. It is seen by the above table that 23 per cent of the male wage receivers own their houses. This may be taken as a fair index of the condition of the whole class in the State, as the number of cases considered is so large as to insure a very close approximation to the true per cent. The counties having a somewhat distinctly rural population have the largest proportion, while the counties of more urban

Persons Owning Houses—Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable,	134	27	20	27	1.00
Berkshire,	510	15	3	15	1.00
Bristol,	1,137	8	-	8	1.00
Dukes,	9	1	11	1	1.00
Essex,	1,771	34	2	34	1.00
Franklin,	291	2	-	2	1.00
Hampden,	1,156	13	1	13	1.00
Hampshire,	269	4	1	4	1.00
Middlesex,	4,215	70	2	70	1.00
Nantucket,	12	-	-	-	-
Norfolk,	665	44	7	44	1.00
Plymouth,	615	16	3	16	1.00
Suffolk,	2,756	14	-	14	1.00
Worcester,	2,284	39	2	39	1.00
For the State,	15,824	287	2	287	1.00

characteristics have the smallest. Barnstable County has 39 per cent of house-owners, and Suffolk only 11. Berkshire County, for some reason not apparent, is below the average. By reference to Part II., it will be found that a similar exhibit is made among the salaried class, even to the peculiarity of showing Berkshire, an essentially rural county, considerably below other counties with a population pursuing like occupations.

The aggregation of those who own houses with those who hire, given a few pages further on, does not, of course, equal the whole number of persons returning schedules, as wage (or salaried) persons who board would not consider the question applicable to them, and therefore would not reply.

Amount of Mortgage—Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . .	1,231	122	10	$47,173 00	$386 66
Berkshire, . .	2,143	195	9	127,032 00	651 45
Bristol, . . .	3,147	158	5	156,120 00	988 10
Dukes, . . .	215	5	2	2,326 00	465 20
Essex, . . .	6,277	594	9	550,860 00	927 37
Franklin, . .	1,329	169	13	117,637 00	696 08
Hampden, . .	3,575	334	9	646,648 00	1,936 07
Hampshire, . .	910	141	15	97,902 00	694 34
Middlesex, . .	11,188	1,399	12	1,408,787 00	1,007 00
Nantucket, . .	11	-	-	-	-
Norfolk, . . .	4,180	637	15	485,079 00	761 51
Plymouth, . .	4,524	535	12	337,300 00	630 47
Suffolk, . . .	5,921	331	6	533,925 00	1,613 07
Worcester, . .	10,864	1,203	11	1,182,027 00	982 57
For the State, .	55,515	5,823	10	5,692,816 00	977 57

Thirteen thousand and forty-six males, and 287 females, by the preceding pages, were seen to be owners of the dwellings in which they live. This is an aggregate of 13,333 persons. Above, it is seen that 5,823 males, and 116 females, have an encumbrance on their houses in the shape of a mortgage. This is an aggregate of 5,939 persons, or about 44½ per cent of those who own houses. In the same way, the proportion of mortgaged houses in Barnstable County is found to be 24 per cent; in Norfolk, 48; in Suffolk, 53; in Hampshire, 57. The aggregate of all mortgages for the males making return is $5,692,816, and the average $977.57. The averages by counties present an interesting exhibit of the probable comparative cost of houses

Amount of Mortgage—Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for al Females answering.	Average for each Female answering.
Barnstable,	134	1	-	$250 00	$250 00
Berkshire,	510	5	1	975 00	195 00
Bristol,	1,137	-	-	-	-
Dukes,	9	-	-	-	-
Essex,	1,771	15	-	8,583 00	572 20
Franklin,	291	2	-	1,800 00	900 00
Hampden,	1,156	6	-	4,500 00	750 00
Hampshire,	269	2	-	800 00	400 00
Middlesex,	4,215	33	-	26,025 00	788 63
Nantucket,	12	-	-	-	-
Norfolk,	665	21	3	11,437 00	544 62
Plymouth,	615	5	-	4,405 00	881 00
Suffolk,	2,756	8	-	8,300 00	1,037 50
Worcester,	2,284	18	-	12,793 00	710 72
For the State,	15,824	116	-	79,868 00	688 52

in different sections, as the amount of mortgage must be a pretty near index of the cost, in a comparative way. While, then, Suffolk County has the least proportion of males owning houses, and the least proportion of mortgages, it is exceeded by but one county in the average amount of each mortgage. Hampshire County has an average for each mortgage of $1,936.07, while in Suffolk it is $1,613.17. In Barnstable County, where was found the largest per cent of persons owning houses, the average of each mortgage is but $386.66.

Rate of Interest—Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . . .	1,231	116	9	864.0	7.5
Berkshire, . . .	2,143	135	6	955.1	7.1
Bristol, ...	3,147	157	5	1,178.5	7.5
Dukes, ...	215	5	2	35.0	7.0
Essex, ...	6,277	587	9	4,403.9	7.5
Franklin, . . .	1,329	173	13	1,203.6	6.9
Hampden, . . .	3,575	422	12	3,009.1	7.1
Hampshire, . . .	910	139	15	1,029.9	7.4
Middlesex, . . .	11,188	1,380	12	10,457.9	7.6
Nantucket, . . .	11	-	-	-	-
Norfolk, . . .	4,180	645	15	4,721.2	7.3
Plymouth, . . .	4,524	531	12	3,875.0	7.3
Suffolk, . . .	5,921	326	6	2,493.1	7.7
Worcester, . . .	10,864	1,208	11	8,585.3	7.1
For the State, . .	55,515	5,824	10	42,811.6	7.4

The average rate of interest paid on mortgages by male wage laborers is $7\frac{4}{10}$, the same as the average for male salaried laborers. The highest rate, $7\frac{7}{10}$, is in Suffolk; Middlesex comes next, $7\frac{6}{10}$. Barnstable, Bristol and Essex are each above the average.

Rate of Interest—Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable, . . .	134	1	-	7.0	7.0
Berkshire, . . .	510	5	1	34.0	6.8
Bristol, ...	1,137	-	-	-	-
Dukes, ...	9	-	-	-	-
Essex, ...	1,771	15	-	112.3	7.5
Franklin, . . .	291	1	-	7.0	7.0
Hampden, . . .	1,156	7	-	47.0	6.7
Hampshire, . . .	269	2	-	14.6	7.3
Middlesex, . . .	4,215	29	-	218.8	7.6
Nantucket, . . .	12	-	-	-	-
Norfolk, . . .	665	20	3	141.8	7.1
Plymouth, . . .	615	5	-	35.0	7.0
Suffolk, . . .	2,756	7	-	60.0	8.6
Worcester, . . .	2,284	18	-	129.3	7.2
For the State, . .	15,824	110	-	806.8	7.3

Number of Rooms hired by Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . .	1,231	223	18	1,071	4.80
Berkshire, . .	2,143	900	42	4,701	5.22
Bristol, . . .	3,147	1,389	44	7,241	5.21
Dukes, . . .	215	38	18	210	5.53
Essex, . . .	6,277	2,910	46	13,680	4.70
Franklin, . . .	1,329	520	39	2,480	4.77
Hampden, . .	3,575	1,728	48	8,774	5.07
Hampshire, . .	910	350	38	1,950	5.57
Middlesex, . .	11,188	5,144	46	24,321	4.73
Nantucket, . .	11	3	27	13	4.33
Norfolk, . . .	4,180	1,618	39	8,310	5.14
Plymouth, . .	4,524	1,526	34	7,789	5.10
Suffolk, . . .	5,921	3,527	59	14,376	4.08
Worcester, . .	10,864	5,129	47	20,398	3.98
For the State, .	55,515	25,005	45	115,314	4.61

The question in regard to "rooms hired" elicited two points. Firstly, the number of those who hire; and secondly, the number of rooms hired. The average in respect to the first point is shown to be 45 per cent for the State among males, and 7 per cent among females. In Suffolk County, 59 per cent, in Hampden, 48, in Worcester, 47, in Essex, 46, and in Middlesex, 46, are all above the average. The per cent of those who hire is the lowest in Barnstable, where it was found the largest number owned houses. The number of rooms hired is the highest in Hampshire, being 5.57 to each male. It is the lowest in Worcester, where it is 3.98 to each. Suffolk, with an average of 4.08, approaches very near to this.

Number of Rooms hired by Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable,	134	8	6	39	4.88
Berkshire,	510	50	10	210	4.20
Bristol,	1,137	74	7	345	4.66
Dukes,	9	-	-	-	-
Essex,	1,771	153	9	528	3.45
Franklin,	291	9	3	39	4.33
Hampden,	1,156	88	8	305	3.47
Hampshire,	269	19	7	60	3.16
Middlesex,	4,215	230	5	722	3.14
Nantucket,	12	-	-	-	-
Norfolk,	665	46	7	192	4.17
Plymouth,	615	29	5	114	3.93
Suffolk,	2,756	260	9	649	2.50
Worcester,	2,284	129	6	491	3.81
For the State,	15,824	1,095	7	3,694	3.37

It has been seen that 23 per cent own houses; 45 per cent, or about double the number, answer that they hire. Thus, 68 per cent own or hire. It is probable that the most of the 32 per cent remaining are boarders.

The average number of rooms hired for females is 3.37. The lowest average is in Suffolk County, 2.50, and the highest in Barnstable, 4.88.

Rent Paid by Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . .	1,231	234	19	$11,865 00	$50 71
Berkshire, . .	2,143	977	46	57,620 00	58 98
Bristol, . . .	3,147	1,433	46	154,670 00	107 93
Dukes, . . .	215	44	20	2,060 00	46 82
Essex, . . .	6,277	2,954	47	310,467 00	105 10
Franklin, . .	1,329	540	41	41,302 00	76 48
Hampden, . .	3,575	1,728	48	198,561 00	114 91
Hampshire, . .	910	353	39	27,973 00	79 24
Middlesex, . .	11,188	5,148	46	598,229 00	116 21
Nantucket, . .	11	3	27	122 00	40 66
Norfolk, . . .	4,180	1,750	42	144,864 00	82 77
Plymouth, . .	4,524	1,581	35	128,999 00	81 59
Suffolk, . . .	5,921	3,534	60	576,883 00	163 23
Worcester, . .	10,864	5,126	47	517,340 00	100 92
For the State, .	55,515	25,405	46	2,770,955 00	109 07

The percentages of those answering as to the amount paid for rent vary but slightly from the percentages of those who hire; 25,005 males, and 1,095 females, hire rooms; and 25,405 males, and 1,098 females, give the amounts paid for rent. The average for males throughout the State is $109.07, and for females, $93.62. Rent is an important item in the family expenses. The yearly wages of males was found to be $482.72. The amount paid for rent is 22½ per cent of this sum. A comparison of the same points among salaried workers shows that the amount paid for rent by males is 22 per cent of the yearly wages.

Rent Paid by Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable, . .	134	9	7	$360 00	$40 00
Berkshire, . .	510	50	10	2,502 00	50 04
Bristol, . . .	1,137	76	7	7,080 00	93 16
Dukes, . . .	9	-	-	-	-
Essex, . . .	1,771	138	8	11,647 00	84 40
Franklin, . .	291	9	3	631 00	70 11
Hampden, . .	1,156	87	8	5,961 00	68 52
Hampshire, . .	269	19	7	978 00	51 47
Middlesex, . .	4,215	234	5	18,442 00	78 81
Nantucket, . .	12	-	-	-	-
Norfolk, . . .	665	47	7	2,628 00	55 91
Plymouth, . .	615	33	5	2,472 00	74 90
Suffolk, . . .	2,756	272	10	41,524 00	152 66
Worcester, . .	2,284	124	5	8,574 00	69 15
For the State, .	15,824	1,098	7	102,799 00	93 62

The highest rent paid is $163.23, in Suffolk County; and the lowest (except in Nantucket) is $46.82, in Dukes. In Barnstable it is $50.71; in Berkshire, $58.98; and in Hampden, $114.91.

Value of Garden Crops—Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . .	1,231	246	20	$5,278 00	$21 46
Berkshire, . .	2,143	735	34	11,511 00	15 66
Bristol, . . .	3,147	395	13	7,569 00	19 16
Dukes, . . .	215	60	28	1,308 00	21 80
Essex, . . .	6,277	785	12	14,605 00	18 60
Franklin, . . .	1,329	358	27	6,332 00	17 68
Hampden, . .	3,575	652	18	10,050 00	15 41
Hampshire, . .	910	246	27	4,027 00	16 37
Middlesex, . .	11,188	1,180	10	27,440 00	23 25
Nantucket, . .	11	3	27	30 00	10 00
Norfolk, . . .	4,180	896	21	29,304 00	32 70
Plymouth, . .	4,524	1,252	27	27,794 00	22 20
Suffolk, . . .	5,921	47	-	864 00	18 38
Worcester, . .	10,864	2,289	21	45,837 00	20 03
For the State, .	55,515	9,144	16	191,949 00	20 99

Above is shown the tabulation of the returns respecting "garden crops raised and used by the family, less all money expenditures on account of the same." This inquiry refers simply to what are ordinarily known as "kitchen gardens."

The largest per cent of answers was received from Berkshire County, and the smallest from Middlesex. In the former county, 34 per cent of the persons answering are shown to have gardens, and in the latter but 10 per cent. The average for the State, for males, is 16 per cent. The average value of the crops raised, for males, throughout the State, is $20.99. Norfolk County has an average value of $32.70 for garden crops, while Hampden has but $15.41.

Value of Garden Crops—Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable,	134	3	2	$23 00	$7 67
Berkshire,	510	20	4	355 00	17 75
Bristol,	1,137	2	-	50 00	25 00
Dukes,	9	1	11	10 00	10 00
Essex,	1,771	3	-	25 00	8 33
Franklin,	291	-	-	-	-
Hampden,	1,156	10	-	75 00	7 50
Hampshire,	269	2	-	20 00	10 00
Middlesex,	4,215	16	-	319 00	19 94
Nantucket,	12	-	-	-	-
Norfolk,	665	12	2	177 00	14 75
Plymouth,	615	5	-	89 00	17 80
Suffolk,	2,756	-	-	-	-
Worcester,	2,284	20	-	290 00	14 50
For the State,	15,824	94	-	1,433 00	15 24

This was the last question asked on the schedule which had reference to the workman's income. The four preceding ones were, "Amount of yearly wages," "Amount of other earnings," "Amount of wife's earnings," and "Amount of minor children's earnings." An examination of the tables presenting the results elicited by these five questions, in connection with the one which follows this, "Cost of living," will give the reader sufficient data for forming a correct conclusion as to the ability of the wage workman, in Massachusetts, to make his way.

It is probable that more persons have gardens than is shown by the above tables, as some would consider it an impossi-

Cost of Living of Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . .	1,231	879	71	$340,956 00	$387 89
Berkshire, . .	2,143	1,682	78	723,905 00	430 38
Bristol, . . .	3,147	2,218	70	1,064,305 00	479 85
Dukes, . . .	215	195	91	77,656 00	398 24
Essex, . . .	6,277	4,144	66	2,016,171 00	486 53
Franklin, . .	1,329	957	72	408,175 00	426 51
Hampden, . .	3,575	2,643	74	1,505,440 00	569 59
Hampshire, . .	910	619	68	256,126 00	413 77
Middlesex, . .	11,188	8,116	72	4,087,981 00	503 69
Nantucket, . .	11	2	18	1,065 00	532 50
Norfolk, . . .	4,180	3,186	76	1,526,955 00	479 27
Plymouth, . .	4,524	3,110	69	1,318,168 00	423 85
Suffolk, . . .	5,921	3,829	65	2,143,727 00	559 87
Worcester, . .	10,864	7,963	73	3,865,638 00	485 45
For the State, .	55,515	39,543	71	19,336,268 00	488 96

bility to state, in dollars, the value of the crop raised, and so have made no reply to this inquiry.

The "cost of supporting your family (or yourself) for the year ending May 1, 1875," was the form in which this question appeared in the schedule. In considering the result obtained, it must be borne in mind that many of the persons who filled out schedules were unmarried, and had no families dependent on them for support; so that the averages in these tables do not show the cost of supporting *families* in the various counties. An aggregation of the various means of income exhibited in the preceding tables, and a comparison of the results with the averages shown in the "cost of living"

Cost of Living of Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable, . .	134	90	67	$11,736 00	$130 40
Berkshire, . .	510	249	49	45,024 00	180 82
Bristol, . . .	1,137	529	47	98,381 00	185 98
Dukes, . . .	9	2	22	273 00	136 50
Essex, . . .	1,771	778	44	158,009 00	203 10
Franklin, . .	291	130	45	19,866 00	152 81
Hampden, . .	1,156	631	55	121,679 00	192 84
Hampshire, . .	269	120	45	20,353 00	169 61
Middlesex, . .	4,215	2,360	56	422,017 00	178 82
Nantucket, . .	12	4	33	325 00	81 25
Norfolk, . . .	665	293	44	55,846 00	190 60
Plymouth, . .	615	238	39	44,123 00	185 39
Suffolk, . . .	2,756	1,178	43	217,399 00	184 55
Worcester, . .	2,284	1,099	48	193,176 00	175 77
For the State, .	15,824	7,701	49	1,408,207 00	182 86

tables, will indicate pretty clearly whether the people whose cases are here considered are living within or beyond their means. And, of course, the number considered being sufficiently large, and distributed throughout the State, it would furnish a decently accurate index of the condition of the entire wage class of the Commonwealth.

It will be seen by referring to page 40, that there was great variation in the expense for rent in different sections; but it will be noticed by the above tables that there is no great range of expenditure in the cost of living. Seventy-one per cent of males, and 49 per cent of females, who answered, of the wage laborers, have given their "cost of liv-

Number of Volumes in Library—Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, ...	1,231	12	1	1,352	112.67
Berkshire, ...	2,143	22	1	4,998	227.18
Bristol, ...	3,147	34	1	5,969	175.55
Dukes, ...	215	4	2	1,025	256.25
Essex, ...	6,277	124	2	19,360	156.13
Franklin, . . .	1,329	17	1	2,110	124.12
Hampden, ...	3,575	67	2	11,870	177.16
Hampshire, . . .	910	8	-	1,175	146.88
Middlesex, . . .	11,188	190	2	28,472	149.85
Nantucket, . . .	11	-	-	-	-
Norfolk, . . .	4,180	51	1	8,867	173.86
Plymouth, . . .	4,524	58	1	10,856	187.17
Suffolk, . . .	5,921	52	-	8,464	162.77
Worcester, . . .	10,864	169	2	24,046	142.28
For the State, . .	55,515	808	1	128,564	159.11

ing." The average for the former is $488,96, and for the latter, $182.86. The largest average expenses of living among male wage laborers is in Hampden County, where it amounts to $569.59; and the lowest in Barnstable, $387.89. A similar exhibit appears among females. Barnstable County furnishes the lowest average, $130.40, and Essex the highest, $203.10; but Hampden comes up pretty near to the latter sum, being $192.84.

Only one per cent of the male wage laborers have replied that they have libraries of one hundred volumes or over, and less than one per cent of the females. The number of volumes in each library, for the former, is 159.11; and for the

Number of Volumes in Library—Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable, . . .	134	-	-	-	-
Berkshire, . . .	510	-	-	-	-
Bristol,. . . .	1,137	1	-	166	166.00
Dukes, ...	9	-	-	-	-
Essex, ...	1,771	3	-	330	110.00
Franklin, . . .	291	-	-	-	-
Hampden, . . .	1,156	-	-	-	-
Hampshire, . . .	269	-	-	-	-
Middlesex, . . .	4,215	9	-	815	90.56
Nantucket, . . .	12	-	-	-	-
Norfolk, . . .	665	1	-	100	100.00
Plymouth, . . .	615	-	-	-	-
Suffolk, . . .	2,756	3	-	373	124.33
Worcester, . . .	2,284	5	-	844	168.80
For the State, . .	15,824	22	-	2,628	119.45

latter, 119.45. Among the male salaried laborers it is found (Part II.) that 18 per cent have libraries averaging 400.19 volumes to each. Three per cent of the females of the same class answered affirmatively, giving an average of 195.38 volumes to each. Among wage laborers, Berkshire had the largest number of books in each library, being 227.18; and Barnstable the smallest, 112.67. In Dukes, it is seen that the average was 256.25; but as only four males made returns, the number is too small to furnish an average of much value. These figures, of themselves, afford no basis by which to determine the reading proclivities of the people. There is hardly a church in any little hamlet that is not possessed of a

Wife's Earnings.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . .	1,231	150	12	$8,066 00	$53 77
Berkshire, . .	2,143	196	9	20,348 00	103 82
Bristol, . .	3,147	309	10	38,197 00	123 61
Dukes, . . .	215	29	13	1,743 00	60 10
Essex, . . .	6,277	566	9	63,541 00	112 26
Franklin, . .	1,329	130	10	9,990 00	76 85
Hampden, . .	3,575	301	8	36,891 00	122 56
Hampshire, . .	910	87	10	7,757 00	89 16
Middlesex, . .	11,188	1,019	9	116,170 00	114 00
Nantucket, . .	11	-	-	-	-
Norfolk, . . .	4,180	490	12	41,194 00	84 06
Plymouth, . .	4,524	489	11	39,115 00	79 99
Suffolk, . . .	5,921	305	5	40,313 00	132 17
Worcester, . .	10,864	1,226	11	113,381 00	92 48
For the State, .	55,515	5,297	10	536,706 00	101 32

library of some extent, the volumes of which circulate freely and constantly among its members. This is the case generally with the hundreds of charitable organizations in the State. Nearly all the smaller villages have social libraries supported by the contributions of members, and the more important towns and cities maintain free libraries, often of many thousand volumes, open to every inhabitant. The newspapers and magazines found in almost every house, furnish additional sources of supply of reading matter. The great proportion of wage laborers undoubtedly read a daily paper each day. The figures given in the tables may be considered

as representing those persons having a specially lite: who love books and desire to accumulate them.

In the preceding tables, only libraries of one volumes or over, have been considered.

Ten per cent of the males are found to have wives earning on an average $101.32. The lowest pe answers is from Suffolk County, which furnishes th average sum to each male answering, being $132.17 be noticed that the counties returning the smallest of answers afford the highest averages of earnings and that the counties returning the largest per ce swers afford the lowest averages. Thus Barnstabl has 12 per cent answering the question, and an ave earned of $53.77.

CHAPTER II.

Presentation by Counties, and Exhibit of Av

In this chapter we make a presentation by cou respect to each schedule question.

The whole number of schedules received is shown b and females, the number answering, the per cent ans and the average for each person answering.

A presentation for the State is also given, by whi seen that schedules were received from 71,339 p 55,515 males, and 15,824 females.

It is to be noticed in the tables that follow, commen the succeeding page, that in the two columns of *a* there is a different basis in respect to each questio basis being in each case the unit indicated *in the q* Moreover, these averages, in every instance, are carri to two places of decimals. This, in some cases, as questions "*Who own houses,*" and "*Rate of interest,*" is for uniformity.

Presentation by Counties.

[Note.—For a similar presentation respecting *salaried* persons, see Part II. The facts presented in these tables refer to *wage* laborers.]

Barnstable County.

Whole Number of Schedules Received,—Males, 1,231; Females, 134.

SCHEDULE QUESTIONS.	Number Answering.		Per cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	788	24	64	18	2.86	1.71
Hours employed, .	738	114	60	85	10.78	10.47
Days employed, .	931	122	76	91	224.16	204.89
Daily wages, . .	853	121	69	90	$1.89	$0.66
Yearly wages, .	974	114	79	85	$388.86	$133.44
Other earnings, .	323	17	26	13	$79.66	$25.88
Wife's earnings, .	150	-	12	-	$53.77	-
Children's earnings,	157	4	13	3	$99.85	$46.75
Unable to work, .	25	4	2	3	1.04	1.25
Who own houses, .	484	27	39	20	1.00	1.00
Amount of mortgage, . . .	122	1	10	-	$388.66	$250.00
Rate of interest, .	116	1	9	-	7.50	7.00
Number of rooms hired, . . .	223	8	18	6	4.80	4.88
Rent paid, . .	234	9	19	7	$50.71	$40.00
Value of garden crops, . . .	246	3	20	2	$21.46	$7.67
Cost of living, .	879	90	71	67	$387.89	$130.40
Number of volumes in library, . .	12	-	1	-	112.67	-

Berkshire County.

Whole Number of Schedules Received,—Males, 2,143; Fe

SCHEDULE QUESTIONS.	Number Answering.		Per cent. Answering.		Average son .
	Males.	Females.	M.	F.	Males.
Persons dependent,	1,522	74	71	14	3.3[illegible]
Hours employed, .	2,059	455	96	89	10.3[illegible]
Days employed, .	1,842	463	86	91	247.93
Daily wages, . .	1,786	398	83	78	$1.77
Yearly wages, .	1,971	490	92	96	$431.00
Other earnings, .	152	9	7	2	$112.72
Wife's earnings, .	196	-	9	-	$103.82
Children's earnings,	200	9	9	2	$267.88
Unable to work, .	31	1	1	-	1.03
Who own houses, .	460	15	21	3	1.00
Amount of mortgage, . . .	195	5	9	1	$651.45
Rate of interest, .	135	5	6	1	7.10
Number of rooms hired, . . .	900	50	42	10	5.22
Rent paid, . .	977	50	46	10	$58.98
Value of garden crops, . . .	735	20	34	4	$15.66
Cost of living, .	1,682	249	78	49	$430.38
Number of volumes in library, . .	22	-	1	-	227.18

Bristol County.

Whole Number of Schedules Received,—Males, 3,147; Females, 1,137.

Schedule Questions.	Number Answering.		Per cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	2,189	136	69	12	3.13	1.93
Hours employed, .	3,029	947	96	83	10.14	10.26
Days employed, .	2,678	1,005	85	88	224.29	257.42
Daily wages, . .	2,705	947	86	83	$2.05	$0.94
Yearly wages, .	2,769	1,085	88	95	$456.05	$213.02
Other earnings, .	393	22	12	2	$162.19	$98.09
Wife's earnings, .	309	-	10	-	$123.61	-
Children's earnings,	295	5	9	-	$335.52	$244.60
Unable to work, .	80	2	3	-	1.51	1.00
Who own houses, .	546	8	17	-	1.00	1.00
Amount of mortgage, . . .	158	-	5	-	$988.10	-
Rate of interest, .	157	-	5	-	7.50	-
Number of rooms hired, . . .	1,389	74	44	7	5.21	4.66
Rent paid, . .	1,433	76	46	7	$107.93	$93.16
Value of garden crops, . . .	395	2	13	-	$19.16	$25.00
Cost of living, .	2,218	529	70	47	$479.85	$185.98
Number of volumes in library, . .	34	1	1	-	175.55	166.00

Dukes County.

Whole Number of Schedules Received,—Males, 215; Females, 9.

Schedule Questions.	Number Answering.		Per cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	175	2	81	22	3.63	1.50
Hours employed, .	177	9	82	100	10.26	9.11
Days employed, .	182	8	85	89	188.13	185.00
Daily wages, . .	174	8	81	89	$2.07	$0.78
Yearly wages, .	200	9	93	100	$359.28	$149.56
Other earnings, .	77	2	36	22	$90.77	$12.50
Wife's earnings,	29	-	13	-	$60 10	-
Children's earnings,	15	1	7	11	$48.67	$50.00
Unable to work, .	5	-	2	-	1.20	-
Who own houses, .	106	1	49	11	1.00	1.00
Amount of mortgage, . . .	5	-	2	-	$465.20	-
Rate of interest, .	5	-	2	-	7.00	-
Number of rooms hired, . . .	38	-	18	-	5.53	-
Rent paid, . .	44	-	20	-	$46.82	-
Value of garden crops, . . .	60	1	28	11	$21.80	$10.00
Cost of living, .	195	2	91	22	$398.24	$136.50
Number of volumes in library, . .	4	-	2	-	256.25	-

Essex County.

Whole Number of Schedules Received,—Males, 6,277; Females, 1,771.

Schedule Questions.	Number Answering.		Per cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	4,578	200	73	11	2.96	1.95
Hours employed, .	6,061	1,569	97	89	10.23	10.25
Days employed, .	5,378	1,511	86	85	237.20	257.58
Daily wages, . .	5,215	1,502	83	85	$1.96	$0.89
Yearly wages, .	5,513	1,541	88	87	$461.65	$212.22
Other earnings, .	683	33	11	2	$116.80	$76.58
Wife's earnings, .	566	-	9	-	$112.26	-
Children's earnings,	583	26	9	1	$196.07	$218.04
Unable to work, .	123	8	2	-	1.13	1.00
Who own houses, .	1,450	34	23	2	1.00	1.00
Amount of mortgage, . . .	594	15	9	-	$927.37	$572.20
Rate of interest, .	587	15	9	-	7.50	7.50
Number of rooms hired, . . .	2,910	153	46	9	4.70	3.45
Rent paid, . .	2,954	138	47	8	$105.10	$84.40
Value of garden crops, . . .	785	3	12	-	$18.60	$8.33
Cost of living, .	4,144	778	66	44	$486.53	$203.10
Number of volumes in library, . .	124	3	2	-	156.13	110.00

FRANKLIN COUNTY.

Whole Number of Schedules Received,—Males, 1,329; Females, 291.

SCHEDULE QUESTIONS.	NUMBER ANSWERING.		PER CENT ANSWERING.		AVERAGE FOR EACH PERSON ANSWERING.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	964	31	72	11	2.99	1.74
Hours employed, .	1,270	266	96	91	10.51	10.49
Days employed, .	1,144	251	86	86	247.47	256.85
Daily wages, . .	1,230	257	93	88	$1.82	$0.72
Yearly wages, .	1,208	266	91	91	$438.19	$178.74
Other earnings, .	159	6	12	2	$100.09	$45.50
Wife's earnings, .	130	-	10	-	$76.85	-
Children's earnings,	137	2	10	-	$173.12	$96.50
Unable to work, .	29	-	2	-	1.14	-
Who own houses, .	372	2	28	-	1.00	1.00
Amount of mortgage, . . .	169	2	13	-	$696.08	$900.00
Rate of interest, .	173	1	13	-	6.90	7.00
Number of rooms hired, . . .	520	9	39	3	4.77	4.33
Rent paid, . .	540	9	41	3	$76.48	$70.11
Value of garden crops, . . .	358	-	27	-	$17.68	-
Cost of living, .	957	130	72	45	$426.51	$152.81
Number of volumes in library, . .	17	-	1	-	124.12	-

Hampden County.

Whole Number of Schedules Received,—Males, 3,575; Females, 1,156.

Schedule Questions.	Number Answering.		Per cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	2,692	114	75	10	3.03	1.71
Hours employed, .	3,541	1,090	99	94	9.95	10.89
Days employed, .	3,406	1,088	95	94	249.87	172.78
Daily wages, . .	2,873	1,022	80	89	$1.83	$0.90
Yearly wages, .	3,477	1,106	97	96	$568.48	$219.59
Other earnings, .	324	23	9	2	$143.71	$54.30
Wife's earnings, .	301	-	8	-	$122.56	-
Children's earnings,	334	16	9	1	$517.85	$288.06
Unable to work, .	76	5	2	-	1.11	1.00
Who own houses, .	806	13	23	1	1.00	1.00
Amount of mortgage, . . .	334	6	9	-	$1,936.07	$750.00
Rate of interest, .	422	7	12	-	7.10	6.70
Number of rooms hired, . . .	1,728	88	48	8	5.07	3.47
Rent paid, . .	1,728	87	48	8	$114.91	$68.52
Value of garden crops, . . .	652	10	18	-	$15.41	$7.50
Cost of living, .	2,643	631	74	55	$569.59	$192.84
Number of volumes in library, . .	67	-	2	-	177.16	-

Hampshire County.

Whole Number of Schedules Received,—Males, 910; Females, 269.

Schedule Questions.	Number Answering.		Per Cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	661	16	73	6	3.10	1.56
Hours employed, .	894	246	98	91	9.75	10.41
Days employed, .	813	237	89	88	241.02	260.85
Daily wages, . .	816	243	90	90	$1.79	$0.78
Yearly wages, .	830	243	91	90	$408.01	$192.13
Other earnings, .	100	5	11	2	$87.89	$99.40
Wife's earnings, .	87	-	10	-	$89.16	-
Children's earnings,	74	1	8	-	$183.93	$150.00
Unable to work, .	24	-	3	-	1.13	-
Who own houses, .	247	4	27	1	1.00	1.00
Amount of mortgage, . . .	141	2	15	-	$694.34	$400.00
Rate of interest, .	139	2	15	-	7.40	7.30
Number of rooms hired, . . .	350	19	38	7	5.57	3.16
Rent paid, . .	358	19	39	7	$79.24	$51.47
Value of garden crops, . . .	246	2	27	-	$16.37	$10.00
Cost of living, .	619	120	68	45	$413.77	$169.61
Number of volumes in library, . .	8	-	-	-	146.88	-

Middlesex County.

Whole Number of Schedules Received,—Males, 11,188; Females, 4,215.

Schedule Questions.	Number Answering.		Per cent Answering.		Average for Each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	8,220	484	73	11	3.11	1.60
Hours employed, .	10,971	3,787	98	90	10.29	10.44
Days employed, .	9,913	3,778	89	89	241.33	270.56
Daily wages, . .	10,076	3,687	90	87	$2.06	$0.82
Yearly wages, .	10,102	3,906	90	93	$496.58	$205.24
Other earnings, .	1,123	80	10	2	$133.15	$18.74
Wife's earnings, .	1,019	-	9	-	$114.00	-
Children's earnings,	951	50	8	1	$207.83	$161.90
Unable to work, .	219	11	2	-	1.16	1.18
Who own houses, .	2,648	70	24	2	1.00	1.00
Amount of mortgage, . . .	1,399	33	12	-	$1,007.00	$788.63
Rate of interest, .	1,380	29	12	-	7.60	7.60
Number of rooms hired, . . .	5,144	230	46	5	4.73	3.14
Rent paid, . .	5,148	234	46	5	$116.21	$78.81
Value of garden crops, . . .	1,180	16	10	-	$23.25	$19.94
Cost of living, .	8,116	2,360	72	56	$503.69	$178.83
Number of volumes in library, . .	190	9	2	-	149.85	90.56

Nantucket County.

Whole Number of Schedules Received,—Males, 11; Females, 12.

Schedule Questions.	Number Answering.		Per cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	M.	Males.	Females.
Persons dependent,	10	3	91	25	2.00	1.00
Hours employed, .	11	12	100	100	9.73	10.00
Days employed, .	11	12	100	100	251.18	254.17
Daily wages, . .	8	9	73	75	$1.47	$0.44
Yearly wages, .	11	12	100	100	$327.73	$88.67
Other earnings, .	4	1	36	8	$41.25	$100.00
Wife's earnings, .	-	-	-	-	-	-
Children's earnings,	-	-	-	-	-	-
Unable to work, .	-	-	-	-	-	-
Who own houses, .	7	-	64	-	1.00	-
Amount of mortgage, . . .	-	-	-	-	-	-
Rate of interest, .	-	-	-	-	-	-
Number of rooms hired, . . .	3	-	27	-	4.33	-
Rent paid, . .	3	-	27	-	$40.66	-
Value of garden crops, . . .	3	-	27	-	$10.00	-
Cost of living, .	2	4	18	33	$532.50	$81.25
Number of volumes in library, . .	-	-	-	-	-	-

Norfolk County.

Whole Number of Schedules Received,—Males, 4,180; Females, 665.

Schedule Questions.	Number Answering.		Per cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	3,154	90	75	14	3.18	1.81
Hours employed, .	3,964	562	95	85	10.14	10.49
Days employed, .	3,697	566	88	85	224.59	237.46
Daily wages, . .	3,789	491	91	74	$1.87	$0.85
Yearly wages, .	3,824	612	91	92	$447.18	$148.54
Other earnings, .	597	32	14	5	$109.70	$69.34
Wife's earnings, .	490	-	12	-	$84.06	-
Children's earnings,	448	18	11	3	$199.19	$194.39
Unable to work, .	82	1	2	-	1.15	1.00
Who own houses, .	1,318	44	32	7	1.00	1.00
Amount of mortgage, . . .	637	21	15	3	$761.51	$544.62
Rate of interest, .	645	20	15	3	7.30	7.10
Number of rooms hired, . . .	1,618	46	39	7	5.14	4.17
Rent paid, . .	1,750	47	42	7	$82.77	$55.91
Value of garden crops, . . .	896	12	21	2	$32.70	$14.75
Cost of living, .	3,186	293	76	44	$479.27	$190.60
Number of volumes in library, . .	51	1	1	-	173.86	100.00

PLYMOUTH COUNTY.

Whole Number of Schedules Received,—Males, 4,524; Females, 615.

SCHEDULE QUESTIONS.	NUMBER ANSWERING.		PER CENT ANSWERING.		AVERAGE FOR EACH PERSON ANSWERING.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	3,241	65	72	10	3.06	2.09
Hours employed, .	4,349	492	96	80	9.96	9.84
Days employed, .	4,050	508	89	83	205.48	235.09
Daily wages, . .	4,033	476	89	77	$2.01	$0.96
Yearly wages, .	4,197	579	93	94	$403.30	$182.14
Other earnings, .	838	37	19	6	$93.60	$72.62
Wife's earnings, .	489	-	11	-	$79.99	-
Children's earnings,	410	8	9	1	$165.93	$209.88
Unable to work, .	115	6	3	1	1.13	1.00
Who own houses, .	1,587	16	35	3	1.00	1.00
Amount of mortgage, . .	535	5	12	-	$630.47	$881.00
Rate of interest, .	531	5	12	-	7.30	7.00
Number of rooms hired, . . .	1,526	29	34	5	5.10	3.93
Rent paid, . .	1,581	33	35	5	$81.59	$74.90
Value of garden crops, . . .	1,252	5	27	-	$22.20	$17.80
Cost of living, .	3,110	238	69	39	$423.85	$185.39
Number of volumes in library, . .	58	-	1	-	187.17	-

Suffolk County.

Whole Number of Schedules Received,—Males, 5,921; Females, 2,756.

Schedule Questions.	Number Answering.		Per cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	4,536	348	77	13	3.03	1.81
Hours employed, .	5,601	1,922	95	70	10.35	11.06
Days employed, .	5,318	2,398	89	87	252.21	298.31
Daily wages, . .	5,304	2,456	89	89	$2.29	$0.71
Yearly wages, .	5,296	2,567	89	93	$576.19	$197.87
Other earnings, .	369	52	6	2	$173.18	$113.98
Wife's earnings, .	305	–	5	–	$132.17	-
Children's earnings,	300	35	5	1	$224.05	$123.29
Unable to work, .	119	13	2	–	1.13	1.07
Who own houses, .	622	14	11	–	1.00	1.00
Amount of mortgage, . . .	331	8	6	–	$1,613.07	$1,037.50
Rate of interest, .	326	7	6	–	7.70	8.60
Number of rooms hired, . . .	3,527	260	59	9	4.08	2.50
Rent paid, . .	3,534	272	60	10	$163.23	$152.66
Value of garden crops, . . .	47	–	–	–	$18.38	-
Cost of living, .	3,829	1,178	65	43	$559.87	$184.55
Number of volumes in library, . .	52	3	–	–	162.77	124.33

Worcester County.

Whole Number of Schedules Received,—Males, 10,864; Females, 2,284.

Schedule Questions.	Number Answering.		Per cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	7,950	196	73	9	3.04	1.65
Hours employed, .	10,639	2,036	98	89	10.22	10.29
Days employed, .	8,418	2,050	77	90	266.24	252.77
Daily wages, . .	9,885	1,976	91	87	$2.00	$0.85
Yearly wages, .	9,695	2,129	89	93	$490.78	$191.07
Other earnings, .	1,295	97	12	4	$114.54	$73.43
Wife's earnings, .	1,226	-	11	-	$92.48	-
Children's earnings,	1,009	28	9	1	$200.94	$155.57
Unable to work, .	257	6	2	-	1.13	1.00
Who own houses, .	2,393	39	22	2	1.00	1.00
Amount of mortgage, . . .	1,203	18	11	-	$982.57	$710.72
Rate of interest, .	1,208	18	11	-	7.10	7.20
Number of rooms hired, . . .	5,129	129	47	6	3.98	3.81
Rent paid, . .	5,126	124	47	5	$100.92	$69.15
Value of garden crops, . . .	2,289	20	21	-	$20.03	$14.50
Cost of living, .	7,963	1,099	73	48	$485.45	$175.77
Number of volumes in library, . .	169	5	2	-	142.28	168.80

For the State.

Whole Number of Schedules Received,—Males, 55,515; Females, 15,824.

SCHEDULE QUESTIONS.	Number Answering.		Per cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	40,680	1,788	73	11	3.08	1.78
Hours employed, .	53,304	13,507	96	85	10.21	10.49
Days employed, .	47,781	13,997	86	88	241.65	258.96
Daily wages, . .	48,747	13,593	88	86	$2.01	$0.82
Yearly wages, .	50,062	14,659	90	93	$482.72	$198.76
Other earnings, .	6,437	416	12	3	$119.69	$78.09
Wife's earnings, .	5,297	-	10	-	$101.82	-
Children's earnings,	4,913	203	9	1	$227.65	$182.01
Unable to work, .	1,185	57	2	-	1.16	1.07
Who own houses, .	13,046	287	23	2	1.00	1.00
Amount of mortgage, . . .	5,823	116	10	-	$977.57	$688.52
Rate of interest, .	5,824	110	10	-	7.40	7.30
Number of rooms hired, . . .	25,005	1,095	45	7	4.61	3.37
Rent paid, . .	25,405	1,098	46	7	$109.07	$93.62
Value of garden crops, . . .	9,144	94	16	-	$20.99	$15.24
Cost of living, .	39,543	7,701	71	49	$488.96	$182.86
Number of volumes in library, . .	808	22	1	-	159.11	119.45

EXHIBIT OF AVERAGES.

The four pages of tables following present in a condensed form the results arrived at by the tabulation of all the schedules received, 71,339; 55,515 from males, and 15,824 from females. The averages thus obtained occupy but little space in a report like this, but the amount of preliminary work done in the production of this single table of four pages was very great. We think, however, its value is certainly commensurate with the labor.

It does not seem necessary that we should enter into any discussion of the many subjects for which these figures furnish the strongest basis. It would be a difficult matter to know where to stop, and whatever we could say would be of far less value than the simple tables themselves.

No explanation is necessary in order to their complete understanding, except perhaps to say, that wherever blanks occur, the question was inapplicable, as "Wife's earnings," to which there could be no answer by females, or in a few cases where no replies were received.

EXHIBIT OF AVERAGES.

[NOTE.—For a similar exhibit respecting *salaried* persons, see Part II. The averages presented in these tables refer to *wage* laborers.]

Average for each Person answering each Inquiry.

SCHEDULE QUESTIONS.	BARNSTABLE.		BERKSHIRE.		BRISTOL.		DUKES.	
	Males.	Females.		Females.	Males.	Females.	Males.	Females.
. . . .	2.86	1.71	3.39	2.27	3.13	1.93	3.63	1.50
. . . .	10.78	10.47	10.35	10.49	10.14	10.26	10.26	9.11
. . . .	224.16	204.89	247.93	266.39	224.29	257.42	188.13	185.00
. . . .	$1.89	$0.66	$1.77	$0.72	$2.05	$0.94	$2.07	$0.78
. . . .	$388.86	$133.44	$431.00	$179.40	$456.05	$213.02	$359.28	$149.56
. . . .	$79.66	$25.88	$112.72	$80.56	$162.19	$98.09	$90.77	$12.50
. . . .	$53.77	-	$103.82	-	$123.61	-	$60.10	-
Children's earnings, ...	$99.85	$46.75	$267.88	$324.89	$335.52	$244.60	$48.67	$50.00
Unable to work, ...	1.04	1.25	1.03	1.00	1.61	1.00	1.20	-
Who own houses, ...	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Amount of mortgage, ...	$386.66	$250.00	$651.45	$195.00	$988.10	-	$465.20	-
Rate of interest, ...	7.50	7.00	7.10	6.80	7.50	-	7.00	-
Number of rooms hired, . . .	4.80	4.88	5.22	4.20	5.21	4.66	5.53	-
Rent paid, ...	$50.71	$40.00	$58.98	$50.04	$107.93	$93.16	$46.82	-
Value of garden crops, . . .	$21.16	$7.67	$15.66	$17.75	$19.16	$25.00	$21.80	$10.00
Cost of living, ...	$387.89	$180.40	$430.38	$180.82	$479.85	$185.98	$398.24	$136.50
Number of volumes in library, . .	112.67	-	227.18	-	175.55	166.00	256.25	-

Average for each Person answering each Inquiry—Continued.

SCHEDULE QUESTIONS.	Essex.		Franklin.		Hampden.		Hampshire.	
	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.
Persons dependent,	2.96	1.95	2.99	1.74	3.03	1.71	3.10	1.56
Hours employed,	10.23	10.25	10.51	10.49	9.95	10.89	9.75	10.41
Days employed,	237.20	257.58	247.47	256.85	249.87	172.78	241.02	260.85
Daily wages,	$1.96	$0.89	$1.82	$0.72	$1.83	$0.90	$1.79	$0.78
Yearly wages,	$461.65	$212.22	$438.19	$178.74	$563.48	$219.59	$408.01	$192.13
Other earnings,	$116.80	$76.58	$100.09	$45.50	$143.71	$54.30	$87.89	$99.40
Wife's earnings,	$112.26	-	$76.85	-	$122.56	-	$89.16	-
Children's earnings,	$196.07	$218.04	$173.12	$96.50	$517.85	$288.06	$183.93	$150.00
Unable to work,	1.13	1.00	1.14	-	1.11	1.00	1.13	-
Who own houses,	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Amount of mortgage,	$927.37	$572.20	$696.08	$900.00	$1,936.07	$750.00	$694.34	$400.00
Rate of interest,	7.50	7.50	6.90	7.00	7.10	6.70	7.40	7.30
Number of rooms hired,	4.70	3.45	4.77	4.33	5.07	3.47	5.57	3.16
Rent paid,	$105.10	$84.40	$76.48	$70.11	$114.91	$68.52	$79.24	$51.47
Value of garden crops,	$18.60	$8.33	$17.68	-	$15.41	$7.50	$16.37	$10.00
Cost of living,	$486.53	$203.10	$426.51	$152.81	$569.59	$192.84	$413.77	$169.61
Number of volumes in library,	156.13	110.00	124.12	-	177.16	-	146.88	-

Average for each Person answering each Inquiry—Continued.

SCHEDULE QUESTIONS.	Middlesex.		Nantucket.		Norfolk.		Plymouth.	
	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.
	3.11	1.60	2.00	1.00	3.18	1.81	3.06	2.09
	10.29	10.44	9.73	10.00	10.14	10.49	9.96	9.84
	241.33	270.56	251.18	254.17	224.59	237.46	205.48	235.09
	$2.06	$0.82	$1.47	$0.44	$1.87	$0.85	$2.01	$0.96
	$496.58	$205.24	$327.73	$88.67	$447.18	$148.54	$403.30	$182.14
	$133.15	$18.74	$41.25	$100.00	$109.70	$69.34	$93.60	$72.62
	$114.00	–	–	–	$84.06	–	$79.99	–
	$207.83	$161.90	–	–	$199.19	$194.39	$165.93	$209.88
Unable to work,	1.16	1.18	–	–	1.15	1.00	1.13	1.00
Who own houses,	1.00	1.00	1.00	–	1.00	1.00	1.00	1.00
Amount of mortgage,	$1,007.00	$788.63	–	–	$761.51	$544.62	$630.47	$881.00
Rate of interest,	7.60	7.60	–	–	7.30	7.10	7.30	7.00
Number of rooms hired,	4.73	3.14	4.33	–	5.14	4.17	5.10	3.93
Rent paid,	$116.21	$78.81	$40.66	–	$82.77	$55.91	$81.59	$74.90
Value of garden crops,	$23.25	$19.94	$10.00	–	$32.70	$14.75	$22.20	$17.80
Cost of living,	$503.69	$178.82	$532.50	$81.25	$479.27	$190.60	$423.85	$185.39
Number of volumes in library,	149.85	90.56	–	–	173.86	100.00	187.17	–

Average for each Person answering each Inquiry—Concluded.

SCHEDULE QUESTIONS.	SUFFOLK.				FOR THE STATE.	
	Males.	Females.			Males.	Females.
	3.03	1.81			3.06	1.78
	10.35	11.06			10.21	10.49
	252.21	298.31			241.65	258.96
	$2.29	$0.71			$2.01	$0.82
	$576.19	$197.87			$482.72	$198.76
	$173.18	$113.98			$119.69	$78.09
	$132.17	–			$101.32	–
	$224.05	$128.29	$200.94	$155.57	$227.65	$182.01
Unable to work,	1.13	1.07	1.13	1.00	1.16	1.07
Who own houses,	1.00	1.00	1.00	1.00	1.00	1.00
Amount of mortgage,	$1,613.07	$1,037.50	$982.57	$710.72	$977.57	$688.52
Rate of interest,	7.70	8.60	7.10	7.20	7.40	7.30
Number of rooms hired,	4.08	2.50	3.98	3.81	4.61	3.37
Rent paid,	$163.23	$152.66	$100.92	$69.15	$109.07	$93.62
Value of garden crops,	$18.88	–	$20.03	$14.50	$20.99	$15.24
Cost of living,	$559.87	$184.55	$485.45	$175.77	$488.96	$182.86
Number of volumes in library,	162.77	124.33	142.28	168.80	159.11	119.45

CHAPTER III.

Family Presentation.

The three following tables make an exhibit of the condition of a large number of families, the male head of which is a wage laborer, in various parts of the State, with reference to nine questions. The first table is made up from the returns of all males who have wives at work; the second, from all who have minor children at work; and the third, from all who have both wives and children at work. In Chapters I. and II. is shown the condition of *all* the wage laborers of the State, with reference to the seventeen questions asked in the Individual Schedules. The showing thus made, of course, includes the returns from which the tables in this chapter are made up. The returns used in this chapter were separated from the mass for the sake of finding, by families, the unit of earnings, etc., of these three classes. In connection with this subject, the attention of the reader is called to Part IV., Chap. IV. (page 354), of our last Report, where will be found much relevant information. In looking at the tables, the question may arise in the minds of some, how it is, if each table is an aggregated exhibit of the condition of families, that the "number answering" should be different for each inquiry. The explanation lies simply in the fact that hardly a person would find *every* question applicable. By Table I., it is seen that 4,379 schedules are considered. On 4,008 of these, there were answers as to "persons dependent"; on 4,187, there were answers as to "yearly wages," etc. This has been explained in another place, but the explanation is reproduced here to prevent a possible misunderstanding.

One point of especial value is shown by these tables. In Chap. I. (page 24), the average yearly wages of male wage laborers is shown to be $482.72.

It is seen, by Table I. of this chapter, that the yearly wages of male wage laborers having wives at work is $467.34; by Table II., that the average for those having children at work is $481.81; and by Table III., that for those having both wives and children at work it is $425.64.

Thus, it is seen, that, in neither of the cases where the head of the family is assisted by his wife or children, does he earn as much as other laborers. Also, that in the case where he is assisted by both wife and children, he earns the least. As this is corroborative of investigations and inquiries made by this Bureau nearly two years ago, attention is called to Part I., and especially to page 47, of our last Report, where will be found the results of those investigations.

TABLE I.—PRESENTATION OF RETURNS FROM MALE WAGE LABORERS WHO HAVE WIVES AT WORK.

Whole Number of Schedules Received, ... 4,379.

SCHEDULE QUESTIONS.	No. of Males answering.	Aggregate for all Males answering.	Average for each Male answering.
Persons dependent, ...	4,008	10,675	2.66
Yearly wages, ...	4,187	$1,910,048	$467.34
Other earnings, ...	923	$87,412	$94.70
Wife's earnings, ...	4,379	$471,927	$107.77
Value of garden crops, . . .	1,258	$24,002	$19.08
Cost of living, ...	3,743	$1,648,022	$440.29
Who own houses, ...	1,277	1,277	1.00
Number of rooms hired, . .	2,559	12,399	4.85
Rent paid, ...	2,471	$235,749	$95.41

The presentation immediately preceding relates to families, and the number of persons represented by the returns is about 16,000. Four thousand three hundred and seventy-nine male heads of families serve as the basis of the several

averages obtained by the manipulation. Those males who are assisted in earnings by "wife" (and no other member of the family) are included.

It will be observed that the number of returns embraced in the table is very large, larger, in fact, than any used as a basis of a presentation of similar character in this country; and, as far as our observation has extended, we have not learned of any efforts of the same magnitude in any other country.

The results, as tabulated, are entitled to earnest and close examination, it being claimed that they are unusually complete; and the utmost care has been taken in the preparation of the table. The figures express clearly the manner in which the aggregate income is secured, and the details, as to disbursements, are of interest to all. As the table referred to is exclusively devoted to male heads of families who are assisted by "wife's earnings," the number used as a basis necessarily differs from the number used in each of the two tables following.

Reference to the table shows that the average number of persons dependent for support upon each male answering, as established by returns from 4,008, is $2\frac{66}{100}$.

The average yearly earnings for each male, of 4,187 answering, is $467.34.

Another source of income is from family gardens,—"value of garden crops,"—the amount stated as an average being in excess of all money outlay on account of the same. As stated in the table, the number answering this question was 1,258. All that is claimed at this point, is, that just that number, being 28+ per cent of the number making returns, are assisted to the extent of the average amount stated.

Relative to other earnings, an examination of the table reveals the fact that 923 males (21 per cent of the whole number making returns) receive an average amount each of $94.70 from labor other than that performed at their usual occupations.

The number of cases in which the wife receives wages being 4,379, the average yearly earnings is seen to be $107.77.

As a *résumé* of statements relating to income for the families referred to, we find the average income of the male head of a family, as established by 4,187 answers, is $467.34. Average income from wife's earnings, as established by 4,379 answers, is $107.77. Aggregating, from the two sources, an average income of $575.11 to each of 4,187 families.

The "cost of living," as illustrated by an average of the families where the wife, in each, assists the husband in securing the income, predicated on answers from 3,743 male heads of families, is $440.29. Reference to the table will show that the margin of income, of the male alone, is but slightly in excess of the cost of living, as proven by the averages. It is proper to suggest, at this point, that the reader should notice carefully that the average number dependent for support upon the males, accounted for in the table, is very small, comparatively speaking, being but $2\frac{66}{100}$ persons for each. Inasmuch as it will be found, by a familiarity with the tables to follow, in which the earnings of children will appear, that the average number dependent is much larger, special attention has been called to this fact.

Of the 4,379 males making returns, 1,277 (29+ per cent) owned the houses occupied. It will be seen, by reference to the figures, that payment for rent is a principal expenditure,—2,471 answers determining an average annual payment, for each, of $95.41. From the answers made by 2,559 males, we ascertain that $4\frac{85}{100}$ rooms are occupied by each family. A perusal of Chapters I. and II., devoted to individual returns, will show the averages, as to number of rooms occupied, and rent paid, based upon very much larger numbers. It is, however, regarded as expedient to show such facts in connection with the subject in hand.

TABLE II.—PRESENTATION OF RETURNS FROM MALE WAGE LABORERS WHO HAVE MINOR CHILDREN AT WORK.

Whole Number of Schedules Received, ... *3,675.*

SCHEDULE QUESTIONS.	No. of Males answering.	Aggregate for all Males answering.	Average for each Male answering.
Persons dependent, . . .	3,509	16,974	4.84
Yearly wages, ...	3,509	$1,690,664	$481.81
Other earnings, ...	568	$85,850	$151.14
Minor children's earnings, . .	3,675	$879,008	$239.19
Value of garden crops, . . .	1,156	$23,775	$20.57
Cost of living, ...	3,162	$2,033,095	$642.97
Who own houses, ...	1,456	1,456	1.00
Number of rooms hired, . .	1,979	10,581	5.35
Rent paid, ...	1,984	$211,075	$106.39

The results obtained from Table II. relate exclusively to returns from male heads of families who are assisted by earnings of minor children. The returns used in the exhibit are entirely disconnected from those used in Table I.

Answers are presented from 3,675 male heads of families, representing, approximately, 21,000 persons. The information is of prominent interest, inasmuch as it forcibly substantiates the claim heretofore frequently made, that the head of the family depends largely upon the earnings of his children to enable him to meet the expenses incident to the usual household demands.

While, in the first table, where the figures relate to males who were assisted by "wife's earnings," the average number of persons dependent for support, upon each, is $2\frac{66}{100}$, the figures in Table II., relating to males who were assisted by the earnings of "minor children," determine the average

number to be $4\frac{84}{100}$ persons dependent upon each male answering.

As to the responses in regard to "yearly wages," from the answers made by 3,509 males, it is ascertained that the average amount to each is $481.81. This is an average of $14.47 higher than the average determined by the figures in the first table. "Other earnings" are reported by 568 males, of the 3,675 making returns under this heading, and the average amount to each is $151.14, being an average to each of the whole number referred to of $23.36.

As previously stated, the number of males making answer that they are assisted by earnings of minor children is 3,675, and the average income to each male from such source is $239.19. The income from private gardens being an amount above all money outlay on account of the same, averages, for the 1,156 answering, $20.57. Three thousand one hundred and sixty-two males make statements as to "cost of living." The average, to each, based upon that number, is seen to be $642.97.

Adding the income from the two sources, as in the case with the first table, it will be seen that it averages a total income to the family of $721.07, being an excess of *family earnings* over *family expenditures* of $78.10 each. As shown by the table, the average number of persons dependent for support upon each of the males comprehended in this presentation is $4\frac{84}{100}$. Add the male head in each case, and the average family, such as we are now referring to, numbers $5\frac{84}{100}$ persons. We do not look for any objection to the mild suggestion that the *family* surplus of $78.10 is rather small. Fourteen hundred and fifty-six males, being 39+ per cent of all making returns, owned the houses occupied by them. The average number of rooms hired by each, of 1,979 making returns, is $5\frac{85}{100}$.

The average annual amount paid as rent, as deduced from 1,984 answers, is $106.39.

TABLE III.—PRESENTATION OF RETURNS FROM MALE WAGE LABORERS WHO HAVE BOTH WIVES AND MINOR CHILDREN AT WORK.

Whole Number of Schedules Received, ... *1,133.*

SCHEDULE QUESTIONS.	No. of Males answering.	Aggregate for all Males answering.	Average for each Male answering.
Persons dependent, ...	1,096	4,848	4.42
Yearly wages, ...	1,097	$466,932	$425.64
Other earnings, ...	341	$28,884	$84.70
Wife's and minor children's earnings, ...	1,133	$239,349	$211.25
Value of garden crops, . . .	532	$13,505	$25.39
Cost of living, ...	977	$537,546	$550.20
Who own houses, ...	555	555	1.00
Number of rooms hired, . .	490	2,676	5.46
Rent paid, ...	491	$45,684	$93.04

Table III. is made up from returns made by males whose wives and minor children were in receipt of wages. Eleven hundred and thirty-three males, representing, approximately, 6,000 persons, made returns. The average number of persons dependent for support upon each of these males, as established by 1,096 answers, is $4\frac{42}{100}$. This, it will be observed, differs but slightly from the average entered in Table II. The average annual income to each male, as drawn from 1,097 replies, is $425.64. Receipts from "other earnings" are very small in this division, only 341 males having acknowledged an income from sources other than regular occupations, the average to each being $84.70. One thousand one hundred and thirty-three males who report earnings by wife and minor children, have an average annual income from the source named of $211.25.

The value of garden crops being in excess of all money expenditures on account of the same, amounts to an average of \$25.39 for each of 532 males answering. Regarding the "cost of living," replies from 977 males who were assisted by earnings of wife and minor children prove that the average amount to each is \$550.20. This amount is nearly \$125 in excess of the income to the male head of the family alone, and \$86.69 less than the united earnings of the whole family. Of the 1,133 making returns, 532, or 46+ per cent, owned the houses occupied by them.

Four hundred and ninety returns establish the fact that the average number of rooms occupied by each family is $5\frac{46}{100}$. And, from 491 returns, it is ascertained that the average amount paid for rent, by each one answering, is \$93.04.

CHAPTER IV.

Presentation of Special Cities and Towns, and Exhibit of Averages.

Having, in Chapter II., made an exhibit of the State, by counties, in reference to each of seventeen questions asked in the Individual Schedules, we now proceed to do the same in detail, in respect to *wage laborers*, for eleven important centres of population and industry; viz., the cities of Boston, Fall River, Lawrence, Lowell, Lynn, Springfield, Taunton and Worcester; and the towns of Attleborough, Westfield and Winchendon. The above-named places are situated in different sections of the State. We were led, however, more particularly to select these places, from the fact that they are each somewhat of a centre of a special industry. Fall River, Lawrence and Lowell are devoted chiefly to the manufacture of cotton goods; Lynn, to ladies' boots; Attleborough, to jewellery; Worcester and Taunton, to iron goods,—such as locomotives, nails, hollow ware, nuts and screws, agricultural implements, and to machinery; Westfield, to cigars and whips; Winchendon, to wooden ware,—such as pails, tubs, etc.; Springfield, to various industries, among the most important being the manufacture of firearms, paper boxes and collars, envelops, postal cards, locomotives, steam car carriages, etc.; and Boston, to the multifarious employments that are usually followed in a large city.

The same plan of presentation is adopted that was made use of in Chapter II. A showing is made of the results brought out by each question in the various cities and towns, and a showing of each city and town treated individually, followed by an exhibit of averages, which gives in a condensed form the averages by sexes in each locality for each question.

A somewhat interesting table might be made up by multi-

plying the average daily wages of each town or city by the average number of days employed in the same town or city. This will produce different results from what is found in the table of yearly wages, as the multiplying of factors, which are themselves averages, cannot produce a product which will agree with one arrived at by averaging independently. But these results will be of value in a *comparative* way, as showing in what places the largest yearly sums *may* be earned.

No statement is made of the occupations pursued by the persons returning the schedules from which these tabulations are made up, nor of the number pursuing any particular occupation.

We have not thought it advisable to do this in this chapter, any more than in preceding ones. The reader who desires information in respect to occupations, such as the number engaged in certain employments, the days worked during the year, the wages earned, and the cost of living, is referred to Chapter V.

By the table of daily wages (page 85), it is seen that in the cities of Fall River, Lawrence and Lowell, where the chief business is the manufacture of cotton goods, there is very nearly an agreement in the daily sums earned by males, ranging from $1.93 to $1.97. The highest daily wage seems to be earned in Attleborough, $2.44; in Westfield, it is $2.38; and in Worcester, $2.31. The lowest daily wage is in Springfield, $1.49; although this same city shows a yearly sum earned equal to $603.40, being exceeded only by Westfield, where the yearly wages are $643.79. The daily wages of males are very low in Winchendon as compared with the other places, being $1.85. The yearly wages in this town are seen to be lower than in any other, being $372.98.

The highest amount of "other earnings" for males is in Springfield, $187.34; and the lowest amount in Attleborough, $114.09.

In the matter of children's earnings, an extraordinary exhibit is made by Fall River, where they are seen to be $456.86. No one must make the mistake of supposing this is the average earnings of *each child*. We have explained this in another place, but we repeat the explanation here. In

making this average, the children of *each family* are considered as a unit, whether they be several in number, or whether there be but a single child. Four hundred and fifty-six dollars and eighty-six cents represents the average earnings *per family* of a child or children. In connection with the subject of the profits of child labor, the reader is referred to our last Report, Parts I. and IV., and to Chap. II. of Part III. Especial attention is called to pages 31 to 36, 55, 61 to 63, and 142 to 151. Considering, as heretofore, the schedules received from males, Fall River furnishes the largest per cent of families partly supported by the labor of children. In this city, 14 per cent of those returning schedules have children at work; in Springfield, 12 per cent; in Lowell, 11; in Lawrence, 10; in Westfield, but 5; in Boston, 5; and in Attleborough, 6.

In regard to those who own the houses in which they live, it is seen that in Fall River, as in Boston, there is but a small per cent of males in this fortunate condition. In the former place, 10 per cent, and in the latter, 9, are house-owners; in Lawrence, 10 per cent; in Lowell, 12; and in Taunton, 14: while in Springfield and Winchendon, 25 per cent; in Lynn and Attleborough, 22; and in Westfield, 21 per cent of this class show plainly that other industries, than the textile, the most encourage the purchase of a house.

In Lynn, there is the smallest average of rooms hired, 3.27; but in Boston, the average is only 3.95. In the latter place, the rent paid is greater than in any other, being $163.29; in Winchendon—a rural town—it is the smallest, being $88.40.

In Lawrence, the value of the kitchen garden, as an auxiliary to the support of the family, is greater than in any other of the twelve places considered, being $35.48; Winchendon (a rural town, as just remarked) comes next, with a value equal to $24.52; while Westfield, a town as little metropolitan, returns an average of only $9.37.

Westfield and Springfield show the highest average for "cost of living,"—$639.13 in the former, and $631.77 in the latter place. In the table of "wife's earnings," the returns show that, in Fall River, the average is $226.92. This is 52

per cent above the average for Lawrence, which comes next to Fall River in the amount earned by wives, and 253 per cent above Taunton, which returns the lowest average.

Information of value bearing on this subject, derived from an investigation lesser in extent, but more minute in particulars, can be found in Part IV., Chap. IV. of our last Report. The whole of the chapter referred to will be worth the attention of any one interested in this question; but Table III., on page 360, has the most direct bearing upon the subject.

Throughout these tables, as throughout all others, the percentages in the column headed *per cent answering*, are computed to the nearest unit. Thus, a per cent which is found to be over fifteen and not over fifteen and one-half, is entered as fifteen; over fifteen and one-half and not over sixteen and one-half, it is entered as sixteen. *The averages for each person answering* are carried out to two places of decimals. Under the question, *Persons who own houses* (page 90), the average is *one* in each case, owing to the fact that only affirmative replies are tabulated. The two places of decimals are filled in this column with ciphers, for the sake of uniformity. On page 92, under the question, *Rate of interest*, the averages are represented in the same uniform way by integers and hundredths, the latter expressed decimally. On this same page, the *aggregate for all persons answering* represents the total of the per cents returned by the *number of persons answering*.

These points have been explained in other chapters, where a similar presentation has been made, but are reproduced here for the benefit of the reader who has not examined the chapters consecutively.

Presentation of Special Cities and Towns by Schedule Questions.

Persons Dependent on Males.

Cities and Towns.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Attleborough, . .	464	313	67	889	2.84
Boston, . . .	4,945	3,809	77	11,424	3.00
Fall River, . . .	926	698	75	2,362	3.39
Lawrence, . . .	712	437	61	1,240	2.84
Lowell, . . .	2,015	1,471	73	4,139	2.89
Lynn, ...	784	588	75	1,724	2.93
Springfield, . .	1,200	941	78	2,855	3.03
Taunton, . . .	295	200	68	639	3.19
Westfield, . . .	477	363	76	1,034	2.84
Winchendon, . .	271	195	72	579	2.95
Worcester, . . .	2,559	2,008	78	6,085	3.01

On Females.

Cities and Towns.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Attleborough, . .	137	9	7	15	1.67
Boston, . . .	2,472	324	13	589	1.82
Fall River, . . .	315	46	15	71	1.54
Lawrence, . . .	466	31	7	54	1.74
Lowell, . . .	1,607	128	8	184	1.44
Lynn, ...	195	30	15	51	1.70
Springfield, . .	423	27	6	56	2.07
Taunton, . . .	89	26	29	69	2.65
Westfield, . . .	78	9	12	12	1.33
Winchendon, . .	20	4	20	7	1.75
Worcester, . . .	612	36	6	58	1.61

Hours Employed—Males.

CITIES AND TOWNS.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Attleborough,	464	456	98	4,545	9.97
Boston,	4,945	4,676	93	48,575	10.39
Fall River,	926	890	96	9,093	10.22
Lawrence,	712	697	98	7,090	10.17
Lowell,	2,015	2,008	100	20,346	10.13
Lynn,	784	740	94	7,518	10.16
Springfield,	1,200	1,165	97	11,325	9.72
Taunton,	295	286	97	2,893	10.12
Westfield,	477	477	100	4,808	10.08
Winchendon,	271	259	96	2,715	10.48
Worcester,	2,559	2,485	97	25,518	10.27

Females.

CITIES AND TOWNS.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Attleborough,	137	128	93	1,272	9.94
Boston,	2,472	1,751	71	19,385	11.07
Fall River,	315	304	97	3,025	9.95
Lawrence,	466	455	98	4,659	10.24
Lowell,	1,607	1,594	99	16,354	10.26
Lynn,	195	173	89	1,687	9.75
Springfield,	423	391	92	4,132	10.57
Taunton,	89	87	98	865	9.94
Westfield,	78	78	100	843	10.80
Winchendon,	20	17	85	174	10.24
Worcester,	612	504	82	5,220	10.36

Days Employed—Males.

CITIES AND TOWNS.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Attleborough,	464	437	94	90,186	206.38
Boston,	4,945	4,567	92	1,152,566	254.56
Fall River,	926	704	76	170,318	241.93
Lawrence,	712	597	84	150,942	252.83
Lowell,	2,015	1,788	89	465,148	260.15
Lynn,	784	646	82	152,907	236.69
Springfield,	1,200	1,101	92	292,987	266.11
Taunton,	295	226	77	53,100	234.96
Westfield,	477	473	99	123,879	261.90
Winchendon,	271	200	74	49,103	245.51
Worcester,	2,559	2,090	82	519,608	248.61

Females.

CITIES AND TOWNS.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all answering.	Average for each answering.
Attleborough,	137	133	97	29,842	224.37
Boston,	2,472	2,234	90	669,581	299.72
Fall River,	315	300	95	69,023	230.08
Lawrence,	466	405	87	96,872	239.19
Lowell,	1,607	1,510	94	378,549	250.61
Lynn,	195	167	86	40,981	245.39
Springfield,	423	407	96	110,108	270.53
Taunton,	89	73	82	16,493	225.93
Westfield,	78	75	96	21,061	280.81
Winchendon,	20	9	45	2,100	233.33
Worcester,	612	602	98	171,183	284.34

Daily Wages of Males.

CITIES AND TOWNS.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Attleborough, . .	464	456	98	$1,111 75	$2 44
Boston, . . .	4,945	4,534	92	10,272 51	2 26
Fall River, . . .	926	761	82	1,469 34	1 93
Lawrence, . . .	712	646	91	1,246 48	1 93
Lowell, . . .	2,015	1,896	94	3,729 98	1 97
Lynn, ...	784	601	76	1,382 26	2 30
Springfield, . .	1,200	1,128	94	1,677 04	1 49
Taunton, . . .	295	266	91	509 52	1 91
Westfield, . . .	477	323	68	769 34	2 38
Winchendon, . .	271	225	83	416 11	1 85
Worcester, . . .	2,559	2,325	90	5,380 97	2 31

Of Females.

Attleborough, . .	137	137	100	$136 60	$1 00
Boston, . . .	2,472	2,241	91	1,596 31	71
Fall River, . . .	315	297	94	334 15	1 12
Lawrence, . . .	466	418	90	423 18	1 01
Lowell, . . .	1,607	1,499	93	1,348 08	87
Lynn, ...	195	167	86	170 90	1 02
Springfield, . .	423	400	95	334 82	83
Taunton, . . .	89	87	98	84 96	97
Westfield, . . .	78	62	79	54 00	87
Winchendon, . .	20	11	44	8 45	77
Worcester, . . .	612	583	95	452 66	77

Yearly Wages of Males.

Cities and Towns.	No. of Schedules received.	No. of Males answering.	Per cent. answering.	Aggregate for all Males answering.	Average for each Male answering.
Attleborough, . .	464	445	95	$227,444 00	$511 11
Boston, . . .	4,945	4,555	92	2,597,629 00	570 28
Fall River, . . .	926	770	83	372,705 00	484 03
Lawrence, . . .	712	556	78	280,693 00	504 84
Lowell, . . .	2,015	1,721	85	883,481 00	513 35
Lynn, ...	784	670	85	363,074 00	541 90
Springfield, . .	1,200	1,164	97	702,858 00	603 40
Taunton, . . .	295	231	78	102,513 00	443 78
Westfield, . . .	477	475	99	305,800 00	643 79
Winchendon, . .	271	199	73	74,224 00	372 98
Worcester, . . .	2,559	2,153	84	1,266,528 00	588 26

Of Females.

Cities and Towns.	No. of Schedules received.	No. of Females answering.	Per cent. answering.	Aggregate.	Average.
Attleborough, . .	187	131	96	$29,035 00	$145 30
Boston, . . .	2,472	2,307	93	458,361 00	198 68
Fall River, . . .	315	302	96	79,009 00	261 61
Lawrence, . . .	466	354	76	84,455 00	238 57
Lowell, . . .	1,607	1,506	94	333,279 00	221 30
Lynn, ...	195	178	91	41,091 00	230 84
Springfield, . .	423	412	97	88,213 00	214 10
Taunton, . . .	89	74	83	16,103 00	217 60
Westfield, . . .	78	78	100	19,433 00	249 14
Winchendon, . .	20	11	55	1,754 00	159 45
Worcester, . . .	612	610	100	122,247 00	200 40

Other Earnings of Males.

CITIES AND TOWNS.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Attleborough,	464	43	9	$4,906 00	$114 09
Boston,	4,945	309	6	53,007 00	171 54
Fall River,	926	74	8	*	*
Lawrence,	712	58	8	9,806 00	169 06
Lowell,	2,015	208	10	34,777 00	167 19
Lynn,	784	58	7	8,529 00	147 05
Springfield,	1,200	96	8	17,985 00	187 34
Taunton,	295	32	11	5,137 00	160 53
Westfield,	477	45	9	6,184 00	137 42
Winchendon,	271	26	9	3,293 00	126 65
Worcester,	2,559	252	10	45,124 00	179 06
Of Females.					
Attleborough,	137	6	4	$115 00	$19 16
Boston,	2,472	46	2	5,336 00	116 00
Fall River,	315	3	1	*	*
Lawrence,	466	1	-	10 00	10 00
Lowell,	1,607	18	1	1,632 00	90 66
Lynn,	195	7	3	235 00	33 57
Springfield,	423	6	1	378 00	63 00
Taunton,	89	3	3	530 00	176 66
Westfield,	78	1	1	15 00	15 00
Winchendon,	20	-	-	-	-
Worcester,	612	14	2	1,104 00	78 85

* Imperfect, and not tabulated.

Children's Earnings Returned by Males.

CITIES AND TOWNS.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Attleborough, . .	464	28	6	$6,001 00	$214 32
Boston, . . .	4,945	266	5	59,243 00	222 71
Fall River, . . .	926	128	14	58,478 00	456 86
Lawrence, . . .	712	72	10	20,054 00	278 53
Lowell, . . .	2,015	213	11	53,785 00	252 51
Lynn, ...	784	52	7	10,301 00	198 10
Springfield, . .	1,200	139	12	49,984 00	359 60
Taunton, . . .	295	25	8	5,134 00	205 36
Westfield, . . .	477	23	5	4,844 00	210 61
Winchendon, . .	271	22	8	1,847 00	83 95
Worcester, . . .	2,559	171	7	33,017 00	193 08

By Females.

CITIES AND TOWNS.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Attleborough, . .	137	-	-	-	-
Boston, ...	2,472	32	1	$3,215 00	$100 47
Fall River, . . .	315	1	-	300 00	300 00
Lawrence, . . .	466	2	-	180 00	90 00
Lowell, ...	1,607	14	-	1,440 00	102 86
Lynn, ...	195	3	2	592 00	197 33
Springfield, . .	423	6	1	2,104 00	350 67
Taunton, . . .	89	2	2	600 00	300 00
Westfield, . . .	78	1	1	400 00	400 00
Winchendon, . .	20	-	-	-	-
Worcester, . . .	612	3	-	319	106 33

Unable to Work—Returned by Males.

CITIES AND TOWNS.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Attleborough,	464	7	1	7	1.00
Boston,	4,945	96	2	109	1.13
Fall River,	926	39	4	77	1.97
Lawrence,	712	11	1	11	1.00
Lowell,	2,015	40	2	42	1.05
Lynn,	784	18	2	24	1.33
Springfield,	1,200	28	2	28	1.00
Taunton,	295	3	1	4	1.33
Westfield,	477	9	2	10	1.11
Winchendon,	271	10	4	10	1.00
Worcester,	2,559	51	2	55	1.08

By Females.

Attleborough,	137	3	2	3	1.00
Boston,	2,472	13	-	14	1.08
Fall River,	315	-	-	-	-
Lawrence,	466	-	-	-	-
Lowell,	1,607	4	-	4	1.00
Lynn,	195	3	1	3	1.00
Springfield,	423	2	-	2	1.00
Taunton,	89	1	1	1	1.00
Westfield,	78	-	-	-	-
Winchendon,	20	-	-	-	-
Worcester,	612	1	-	1	1.00

Persons who Own Houses—Males.

CITIES AND TOWNS.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Attleborough,	464	102	22	102	1.00
Boston,	4,945	457	9	457	1.00
Fall River,	926	95	10	95	1.00
Lawrence,	712	83	10	83	1.00
Lowell,	2,015	250	12	250	1.00
Lynn,	784	169	22	169	1.00
Springfield,	1,200	302	25	302	1.00
Taunton,	295	41	14	41	1.00
Westfield,	477	101	21	101	1.00
Winchendon,	271	69	25	69	1.00
Worcester,	2,559	422	16	422	1.00

Females.

Attleborough,	137	3	2	3	1.00
Boston,	2,472	13	-	13	1.00
Fall River,	315	1	-	1	1.00
Lawrence,	466	3	-	3	1.00
Lowell,	1,607	15	1	15	1.00
Lynn,	195	3	2	3	1.00
Springfield,	423	3	-	3	1.00
Taunton,	89	2	2	2	1.00
Westfield,	78	2	3	2	1.00
Winchendon,	20	-	-	-	-
Worcester,	612	3	-	3	1.00

Amount of Mortgages—Males.

CITIES AND TOWNS.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Attleborough, . .	464	43	9	$41,354 00	$961 72
Boston, . . .	4,945	251	6	433,975 00	1,728 98
Fall River, . . .	926	26	3	49,825 00	1,916 34
Lawrence, . . .	712	50	7	48,678 00	973 56
Lowell, . . .	2,015	84	4	82,510 00	982 26
Lynn, ...	784	75	10	98,130 00	1,308 40
Springfield, . .	1,200	200	17	375,167 00	1,875 83
Taunton, . . .	295	17	6	16,850 00	991 18
Westfield, . . .	477	55	12	84,980 00	1,545 09
Winchendon, . .	271	35	13	25,343 00	724 08
Worcester, . . .	2,559	294	11	457,081 00	1,554 69

Females.

CITIES AND TOWNS.	No. of Schedules received.	No. answering.	Per cent answering.	Aggregate for all answering.	Average for each answering.
Attleborough, . .	137	-	-	-	-
Boston, . . .	2,472	7	-	$6,800 00	$971 43
Fall River, . . .	315	-	-	-	-
Lawrence, . . .	466	2	-	925 00	462 50
Lowell, . . .	1,607	5	-	4,700 00	940 00
Lynn, ...	195	1	-	150 00	150 00
Springfield, . .	423	1	-	1,700 00	1,700 00
Taunton, . . .	89	-	-	-	-
Westfield, . . .	78	2	3	1,200 00	600 00
Winchendon, . .	20	-	-	-	-
Worcester, . . .	612	2	-	2,700 00	1,350 00

Rate of Interest—Males.

CITIES AND TOWNS.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Attleborough,	464	42	9	329.80	7.85
Boston,	4,945	246	4	1,877.90	7.63
Fall River,	926	26	3	198.70	7.64
Lawrence,	712	47	6	366.40	7.79
Lowell,	2,015	84	4	609.00	7.25
Lynn,	784	77	10	623.30	8.09
Springfield,	1,200	188	16	1,377.30	7.32
Taunton,	295	17	6	119.00	7.00
Westfield,	477	55	11	405.00	7.36
Winchendon,	271	35	13	251.30	7.18
Worcester,	2,559	286	11	2,016.70	7.05

Females.

Attleborough,	137	-	-	-	-
Boston,	2,472	6	-	51.00	8.50
Fall River,	315	-	-	-	-
Lawrence,	466	2	-	17.00	8.50
Lowell,	1,607	5	-	35.00	7.00
Lynn,	195	1	-	10.00	10.00
Springfield,	423	2	-	13.00	6.50
Taunton,	89	-	-	-	-
Westfield,	78	2	2	14.00	7.00
Winchendon,	20	-	-	-	-
Worcester,	612	2	-	16.50	8.25

Number of Rooms Hired by Males.

CITIES AND TOWNS.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Attleborough,	464	181	39	915	5.05
Boston,	4,945	3,048	62	12,030	3.95
Fall River,	926	507	55	2,488	4.90
Lawrence,	712	314	44	1,668	5.31
Lowell,	2,015	1,220	61	6,132	5.03
Lynn,	784	396	51	1,296	3.27
Springfield,	1,200	577	48	2,953	5.12
Taunton,	295	144	49	753	5.23
Westfield,	477	260	55	1,280	4.92
Winchendon,	271	111	41	578	5.21
Worcester,	2,559	1,472	58	6,951	4.72

By Females.

CITIES AND TOWNS.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Attleborough,	137	8	6	31	3.87
Boston,	2,472	248	10	598	2.48
Fall River,	315	31	10	151	4.87
Lawrence,	466	23	5	65	2.82
Lowell,	1,607	74	5	198	2.67
Lynn,	195	31	16	103	3.32
Springfield,	423	23	5	68	2.96
Taunton,	89	11	12	56	5.09
Westfield,	78	15	19	56	3.73
Winchendon,	20	-	-	-	-
Worcester,	612	32	5	85	3.66

Rent paid by Males.

Cities and Towns.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Attleborough,	464	192	41	$24,950 00	$129 94
Boston,	4,945	3,055	62	498,861 00	163 29
Fall River,	926	522	56	66,814 00	127 99
Lawrence,	712	319	45	41,744 00	130 85
Lowell,	2,015	1,219	60	137,876 00	113 10
Lynn,	784	399	51	54,187 00	135 80
Springfield,	1,200	580	48	81,173 00	139 95
Taunton,	295	148	50	16,022 00	108 25
Westfield,	477	260	55	35,447 00	136 33
Winchendon,	271	109	40	9,636 00	88 40
Worcester,	2,559	1,487	58	221,910 00	149 23

By Females.

Cities and Towns.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Attleborough,	137	7	5	$635 00	$90 71
Boston,	2,472	258	10	29,508 00	114 37
Fall River,	315	33	10	3,916 00	118 66
Lawrence,	466	23	5	1,813 00	78 82
Lowell,	1,607	74	5	5,855 00	79 12
Lynn,	195	31	16	3,133 00	101 06
Springfield,	423	23	5	1,815 00	78 91
Taunton,	89	11	12	955 00	86 81
Westfield,	78	15	19	1,699 00	113 26
Winchendon,	20	-	-	-	-
Worcester,	612	31	5	3,022 00	97 48

Value of Garden Crops Raised by Males.

CITIES AND TOWNS.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Attleborough,	464	72	16	$1,417 00	$19 68
Boston,	4,945	28	-	448 00	16 00
Fall River,	926	12	1	183 00	15 25
Lawrence,	712	21	3	745 00	35 48
Lowell,	2,015	42	2	762 00	18 14
Lynn,	784	34	4	326 00	9 59
Springfield,	1,200	174	15	3,174 00	18 24
Taunton,	295	27	9	375 00	13 88
Westfield,	477	59	12	553 00	9 37
Winchendon,	271	69	25	1,692 00	24 52
Worcester,	2,559	149	6	2,664 00	17 81

By Females.

Attleborough,	137	1	-	$20 00	$20 00
Boston,	2,472	-	-	-	-
Fall River,	815	-	-	-	-
Lawrence,	466	1	-	10 00	10 00
Lowell,	1,607	-	-	-	-
Lynn,	195	-	-	-	-
Springfield,	423	3	-	23 00	7 67
Taunton,	89	1	1	15 00	15 00
Westfield,	78	1	1	3 00	3 00
Winchendon,	20	-	-	-	-
Worcester,	612	1	-	10 00	10 00

Cost of Living of Males.

CITIES AND TOWNS.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Attleborough, . .	464	373	80	$189,300 00	$507 50
Boston, . . .	4,945	3,374	68	1,855,411 00	549 91
Fall River, . . .	926	630	68	320,862 00	509 30
Lawrence, . . .	712	486	68	233,853 00	481 17
Lowell, . . .	2,015	1,462	72	726,982 00	497 25
Lynn, ...	784	459	58	251,785 00	548 55
Springfield, . .	1,200	1,011	84	638,727 00	631 77
Taunton, . . .	295	159	54	82,324 00	517 75
Westfield, . . .	477	266	56	170,009 00	639 13
Winchendon, . .	271	169	62	82,238 00	486 61
Worcester, . . .	2,559	1,753	68	1,029,312 00	587 17

Of Females.

Attleborough, . .	137	72	52	$14,279 00	$198 32
Boston, . . .	2,472	1,071	43	202,566 00	189 13
Fall River, . . .	315	121	38	26,329 00	217 59
Lawrence, . . .	466	307	66	60,573 00	197 30
Lowell, . . .	1,607	1,073	67	189,164 00	176 29
Lynn, ...	195	81	41	17,349 00	214 18
Springfield, . .	423	206	49	39,633 00	192 39
Taunton, . . .	89	44	49	10,216 00	232 18
Westfield, . . .	78	38	49	9,241 00	243 97
Winchendon, . .	20	5	24	789 00	157 80
Worcester, . . .	612	248	40	51,362 00	224 84

Number of Volumes in Library—Males.

CITIES AND TOWNS.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Attleborough, . .	464	5	1	720	144.00
Boston, . . .	4,945	38	-	6,292	165.58
Fall River, . . .	926	4	-	1,033	258.25
Lawrence, . . .	712	14	2	2,506	179.00
Lowell, . . .	2,015	61	3	7,285	119.43
Lynn, ...	784	23	3	3,057	132.91
Springfield, . .	1,200	24	2	3,638	151.60
Taunton, . . .	295	8	3	1,160	140.00
Westfield, . . .	477	18	4	4,209	233.83
Winchendon, . .	271	8	3	1,827	228.37
Worcester, . . .	2,559	40	2	5,522	138.05

Females.

Attleborough, . .	137	-	-	-	-
Boston, . . .	2,472	-	-	-	-
Fall River, . . .	315	-	-	-	-
Lawrence, . . .	466	-	-	-	-
Lowell, . . .	1,607	5	-	310	62.00
Lynn, ...	195	1	-	100	100.00
Springfield, . .	423	-	-	-	-
Taunton, . . .	89	-	-	-	-
Westfield, . . .	78	-	-	-	-
Winchendon, . .	20	-	-	-	-
Worcester, . . .	612	2	-	450	225.00

Wife's Earnings.

CITIES AND TOWNS.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Attleborough, . .	464	31	7	$3,112 00	$100 38
Boston, . . .	4,945	273	5	35,779 00	134 72
Fall River, . . .	926	79	8	17,927 00	226 92
Lawrence, . . .	712	66	9	9,842 00	149 12
Lowell, . . .	2,015	195	10	27,842 00	142 77
Lynn, ...	784	72	9	9,328 00	129 55
Springfield, . .	1,200	86	7	10,395 00	120 87
Taunton, . . .	295	16	5	1,028 00	64 25
Westfield, . . .	477	40	8	4,757 00	118 92
Winchendon, . .	271	20	7	2,577 00	128 85
Worcester, . . .	2,559	160	6	19,106 00	119 41

Presentation by Cities and Towns.

Attleborough.

Whole Number of Schedules Received,—Males, 464; Females, 137.

Schedule Questions.	Number Answering.		Per cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	313	9	67	7	2.84	1.67
Hours employed, .	456	128	98	93	9.97	9.94
Days employed, .	437	133	94	97	206.38	224.37
Daily wages, . .	456	137	98	100	$2.44	$1.00
Yearly wages, .	445	131	95	96	$511.11	$145.30
Other earnings, .	43	6	9	4	$114.09	$19.16
Wife's earnings, .	31	-	7	-	$100.38	-
Children's earnings,	28	-	6	-	$214.32	-
Unable to work, .	7	3	1	2	1.00	1.00
Who own houses, .	102	3	22	2	1.00	1.00
Amount of mortgage, . . .	43	-	9	-	$961.72	-
Rate of interest, .	42	-	9	-	7.85	-
Number of rooms hired, . . .	181	8	39	6	5.05	3.87
Rent paid, . .	192	7	41	5	$129.94	$90.71
Value of garden crops, . . .	72	1	16	-	$19.68	$20.00
Cost of living, .	373	72	80	52	$507.50	$198.32
Number of volumes in library, . .	5	-	1	-	144.00	-

Boston.

Whole Number of Schedules Received,—Males, 4,945; Females, 2,472.

Schedule Questions.	Number Answering.		Per cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	3,809	324	77	13	3.00	1.82
Hours employed, .	4,676	1,751	93	71	10.39	11.07
Days employed, .	4,567	2,234	92	90	254.56	299.72
Daily wages, . .	4,534	2,241	92	91	$2.26	$0.71
Yearly wages, .	4,555	2,307	92	93	$570.28	$198.68
Other earnings, .	309	46	6	2	$171.54	$116.00
Wife's earnings, .	273	-	5	-	$134.72	-
Children's earnings,	266	32	5	1	$222.71	$100.47
Unable to work, .	96	13	2	-	1.13	1.08
Who own houses, .	457	13	9	-	1.00	1.00
Amount of mortgage, . . .	251	7	6	-	$1,728.98	$971.43
Rate of interest, .	246	6	4	-	7.63	8.50
Number of rooms hired, . . .	3,048	248	62	10	3.95	2.48
Rent paid, . .	3,055	258	62	10	$163.29	$114.37
Value of garden crops, . . .	28	-	-	-	$16.00	-
Cost of living, .	3,374	1,071	68	43	$549.91	$189.13
Number of volumes in library, . .	38	-	-	-	165.58	-

Fall River.

Whole Number of Schedules Received,—Males, 926; Females, 315.

SCHEDULE QUESTIONS.	Number Answering.		Per cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	698	46	75	15	3.39	1.54
Hours employed, .	890	304	96	97	10.22	9.95
Days employed, .	704	300	76	95	241.93	230.08
Daily wages, . .	761	297	82	94	$1.93	$1.12
Yearly wages, .	770	302	83	96	$484.03	$261.61
Other earnings, .	74	3	8	1	*	*
Wife's earnings, .	79	-	8	-	$226.92	-
Children's earnings,	128	1	14	-	$456.86	$300.00
Unable to work, .	39	-	4	-	1.97	-
Who own houses, .	95	1	10	-	1.00	1.00
Amount of mortgage, . . .	26	-	3	-	$1,916.34	-
Rate of interest, .	26	-	3	-	7.64	-
Number of rooms hired, . . .	507	31	55	10	4.90	4.87
Rent paid, . .	522	33	56	10	$127.99	$118.66
Value of garden crops, . . .	12	-	1	-	$15.25	-
Cost of living, .	630	121	68	38	$509.30	$217.59
Number of volumes in library, . .	4	-	-	-	258.25	-

* Imperfect, and not tabulated.

Lawrence.

Whole Number of Schedules Received,—Males, 712; Females, 466.

Schedule Questions.	Number Answering.		Per cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	437	81	61	7	2.84	1.74
Hours employed, .	697	455	98	98	10.17	10.24
Days employed, .	597	405	84	87	252.83	239.19
Daily wages, . .	646	418	91	90	$1.93	$1.01
Yearly wages, .	556	354	78	76	$504.84	$238.57
Other earnings, .	58	1	8	-	$169.06	$10.00
Wife's earnings, .	66	-	9	-	$149.12	-
Children's earnings,	72	2	10	-	$278.53	$90.00
Unable to work, .	11	-	1	-	1.00	-
Who own houses, .	83	3	10	-	1.00	1.00
Amount of mortgage, . . .	50	2	7	-	$973.56	$462.50
Rate of interest, .	47	2	6	-	7.79	8.50
Number of rooms hired, . . .	314	23	44	5	5.31	2.82
Rent paid, . .	319	23	45	5	$130.85	$78.82
Value of garden crops, . . .	21	1	3	-	$35.48	$10.00
Cost of living, .	486	307	68	66	$481.17	$197.30
Number of volumes in library, . .	14	-	2	-	179.00	-

LOWELL.

Whole Number of Schedules Received,—Males, 2,015; Females, 1,607.

SCHEDULE QUESTIONS.	NUMBER ANSWERING.		PER CENT ANSWERING.		AVERAGE FOR EACH PERSON ANSWERING.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	1,471	128	73	8	2.89	1.44
Hours employed, .	2,008	1,594	100	99	10.13	10.26
Days employed, .	1,788	1,510	89	94	260.15	250.61
Daily wages, . .	1,896	1,499	94	93	$1.97	$0.87
Yearly wages, .	1,721	1,506	85	94	$513.35	$221.30
Other earnings, .	208	18	10	1	$167.19	$90.66
Wife's earnings, .	195	-	10	-	$142.77	-
Children's earnings,	213	14	11	-	$252.51	$102.86
Unable to work, .	40	4	2	-	1.05	1.00
Who own houses, .	250	15	12	1	1.00	1.00
Amount of mortgage, . . .	84	5	4	-	$982.26	$940.00
Rate of interest, .	84	5	4	-	7.25	7.00
Number of rooms hired, . . .	1,220	74	61	5	5.03	2.67
Rent paid, . . .	1,219	74	60	5	$113.10	$79.12
Value of garden crops, . . .	42	-	2	-	$18.14	-
Cost of living, .	1,462	1,073	72	67	$497.25	$176.29
Number of volumes in library, . .	61	5	3	-	119.43	62.00

Lynn.

Whole Number of Schedules Received,—Males, 784; Females, 195.

SCHEDULE QUESTIONS.	Number Answering.		Per cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	588	30	75	15	2.93	1.70
Hours employed, .	740	173	94	89	10.16	9.75
Days employed, .	646	167	82	86	236.69	245.39
Daily wages, . .	601	167	76	86	$2.30	$1.02
Yearly wages, .	670	178	85	91	$541.90	$230.84
Other earnings, .	58	7	7	3	$147.05	$33.57
Wife's earnings, .	72	-	9	-	$129.55	-
Children's earnings,	52	3	7	2	$198.10	$197.33
Unable to work, .	18	3	2	1	1.33	1.00
Who own houses, .	169	3	22	2	1.00	1.00
Amount of mortgage, . . .	75	1	10	-	$1,308.40	$150.00
Rate of interest, .	77	1	10	-	8.09	10.00
Number of rooms hired, . . .	396	31	51	16	3.27	3.32
Rent paid, . .	399	31	51	16	$135.80	$101.06
Value of garden crops, . . .	34	-	4	-	$9.59	-
Cost of living, .	459	81	58	41	$548.55	$214.18
Number of volumes in library, . .	23	1	3	-	132.91	100.00

SPRINGFIELD.

Whole Number of Schedules Received,—Males, 1,200; Females, 423.

SCHEDULE QUESTIONS.	NUMBER ANSWERING.		PER CENT ANSWERING.		AVERAGE FOR EACH PERSON ANSWERING.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	941	27	78	6	3.03	2.07
Hours employed, .	1,165	391	97	92	9.72	10.57
Days employed, .	1,101	407	92	96	266.11	270.53
Daily wages, . .	1,128	400	94	95	$1.49	$0.83
Yearly wages, .	1,164	412	97	97	$603.40	$214.10
Other earnings, .	96	6	8	1	$187.34	$63.00
Wife's earnings, .	86	-	7	-	$120.87	-
Children's earnings,	139	6	12	1	$359.60	$350.67
Unable to work, .	28	2	2	-	1.00	1.00
Who own houses, .	302	3	25	-	1.00	1.00
Amount of mortgage, . . .	200	1	17	-	$1,875.83	$1,700.00
Rate of interest, .	188	2	16	-	7.32	6.50
Number of rooms hired, . . .	577	23	48	5	5.12	2.96
Rent paid, . .	580	23	48	5	$139.95	$78.91
Value of garden crops, . . .	174	3	15	-	$18.24	$7.67
Cost of living, .	1,011	206	84	49	$631.77	$192.39
Number of volumes in library, . .	24	-	2	-	151.60	-

TAUNTON.

Whole Number of Schedules Received,—Males, 295; Females, 89.

SCHEDULE QUESTIONS.	NUMBER ANSWERING.		PER CENT ANSWERING.		AVERAGE FOR EACH PERSON ANSWERING.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	200	26	68	29	3.19	2.65
Hours employed, .	286	87	97	98	10.12	9.94
Days employed, .	226	73	77	82	234.96	225.93
Daily wages, . .	266	87	91	98	$1.91	$0.97
Yearly wages, .	231	74	78	83	$443.78	$217.60
Other earnings, .	32	3	11	3	$160.53	$176.66
Wife's earnings, .	16	-	5	-	$64.25	-
Children's earnings,	25	2	8	2	$205.36	$300.00
Unable to work, .	3	1	1	1	1.33	1.00
Who own houses, .	41	2	14	2	1.00	1.00
Amount of mortgage, . . .	17	-	6	-	$991.18	-
Rate of interest, .	17	-	6	-	7.00	-
Number of rooms hired, . . .	144	11	49	12	5.23	5.09
Rent paid, . .	148	11	50	12	$108.25	$86.81
Value of garden crops, . . .	27	1	9	1	$13.88	$15.00
Cost of living, .	159	44	54	49	$517.75	$232.18
Number of volumes in library, . .	8	-	3	-	140.00	-

Westfield.

Whole Number of Schedules Received,—Males, 477; Females, 78.

Schedule Questions.	Number Answering.		Per cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	363	9	76	12	2.84	1.33
Hours employed, .	477	78	100	100	10.08	10.80
Days employed, .	473	75	99	96	261.90	280.81
Daily wages, . .	323	62	68	79	$2.38	$0.87
Yearly wages, .	475	78	99	100	$643.79	$249.14
Other earnings, .	45	1	9	1	$137.42	$15.00
Wife's earnings, .	40	-	8	-	$118.92	-
Children's earnings,	23	1	5	1	$210.61	$400.00
Unable to work, .	9	-	2	-	1.11	-
Who own houses, .	101	2	21	3	1.00	1.00
Amount of mortgage, . . .	55	2	12	3	$1,545.09	$600.00
Rate of interest, .	55	2	11	2	7.36	7.00
Number of rooms hired, . . .	260	15	55	19	4.92	3.73
Rent paid, . .	260	15	55	19	$136.33	$113.26
Value of garden crops, . . .	59	1	12	1	$9.37	$3.00
Cost of living, .	266	38	56	49	$639.13	$243.97
Number of volumes in library, . .	18	-	4	-	233.83	-

WINCHENDON.

Whole Number of Schedules Received,—Males, 271; Females, 20.

SCHEDULE QUESTIONS.	NUMBER ANSWERING.		PER CENT ANSWERING.		AVERAGE FOR EACH PERSON ANSWERING.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	195	4	72	20	2.95	1.75
Hours employed, .	259	17	96	85	10.48	10.24
Days employed, .	200	9	74	45	245.51	233.33
Daily wages, . .	225	11	83	44	$1.85	$0.77
Yearly wages, .	199	11	73	55	$372.98	$159.45
Other earnings, .	26	-	9	-	$126.65	-
Wife's earnings, .	20	-	7	-	$128.85	-
Children's earnings,	22	-	8	-	$83.95	-
Unable to work, .	10	-	4	-	1.00	-
Who own houses, .	69	-	25	-	1.00	-
Amount of mortgage, . .	35	-	13	-	$724.08	-
Rate of interest, .	35	-	13	-	7.18	-
Number of rooms hired, . . .	111	-	41	-	5.21	-
Rent paid, . .	109	-	40	-	$88.40	-
Value of garden crops, . . .	69	-	25	-	$24.52	-
Cost of living, .	169	5	62	24	$486.61	$157.80
Number of volumes in library, . .	8	-	3	-	228.37	-

WORCESTER.

Whole Number of Schedules Received,—Males, 2,559; Females, 612.

SCHEDULE QUESTIONS.	NUMBER ANSWERING.		PER CENT. ANSWERING.		AVERAGE FOR EACH PERSON ANSWERING.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	2,003	36	78	6	3.01	1.61
Hours employed, .	2,485	504	97	82	10.27	10.36
Days employed, .	2,090	602	82	98	248.61	284.34
Daily wages, . .	2,325	583	90	95	$2.31	$0.77
Yearly wages, .	2,153	610	84	100	$588.26	$200.40
Other earnings, .	252	14	10	2	$179.06	$78.85
Wife's earnings, .	160	-	6	-	$119.41	-
Children's earnings,	171	3	7	-	$193.08	$106.33
Unable to work, .	51	1	2	-	1.08	1.00
Who own houses, .	422	3	16	-	1.00	1.00
Amount of mortgage, . . .	294	2	11	-	$1,554.69	$1,350.00
Rate of interest, .	286	2	11	-	7.05	8.25
Number of rooms hired, . . .	1,472	32	58	5	4.72	3.66
Rent paid, . .	1,487	31	58	5	$149.23	$97.48
Value of garden crops, . . .	149	1	6	-	$17.81	$10.00
Cost of living, .	1,753	248	68	40	$587.17	$224.84
Number of volumes in library, . .	40	2	2	-	138.05	225.00

Exhibit of Averages for Special Cities and Towns.

In the three tabulated pages following, is presented, in a condensed form, a statement of the averages, by sexes, for each inquiry for each city and town.

These averages, in a few cases, are made up from a small number of returns; and that no one may fall into the error of ascribing the same value to each of them, we desire to distinctly impress this fact upon the reader. We have not thought it best to discard any average, even when derived from only two or three returns, as it *is* of some importance. The basis from which the average is drawn, can be seen, in all cases, by reference to the preceding tables, so that the reader has the opportunity of forming his own estimate of its worth or worthlessness. Some of the averages are based on more than four thousand returns, and, in most cases, the returns are from one hundred to five hundred in number.

We think the numbers generally are sufficiently large to make the averages of considerable importance. If they do not show the exact condition of things, which could only be arrived at by having complete returns from every wage laborer in the cities and towns considered, they are likely to serve as a tolerably correct index of that condition. We present the *facts*, as the people of the Commonwealth have stated them to us. We send them back now to the people, with but little of comment, for their consideration.

Wherever there are blank spaces in the columns, there were either no returns or the question was inapplicable.

Average for each Person answering each Inquiry.

[NOTE.—A few of these returns are deduced from a small number of averages; and that the reader may not ascribe an equal value to all, he is referred to the preceding tables of this chapter, where the basis of computation can be seen.]

SCHEDULE QUESTIONS.	ATTLEBOROUGH.		BOSTON.		FALL RIVER.		LAWRENCE.	
	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.
Persons dependent,	2.84	1.67	3.00	1.82	3.39	1.54	2.84	1.74
Hours employed,	9.97	9.94	10.39	11.07	10.22	9.95	10.17	10.24
Days employed,	206.38	224.37	254.56	299.72	241.93	230.08	252.83	239.19
Daily wages,	$2.44	$1.00	$2.26	$0.71	$1.93	$1.12	$1.93	$1.01
Yearly wages,	$511.11	$145.30	$570.28	$198.68	$484.03	$261.61	$504.84	$238.57
Other earnings,	$114.09	$19.16	$171.54	$116.00	*	*	$169.06	$10.00
Wife's earnings,	$100.38	-	$134.72	-	$226.92	-	$149.12	-
Children's earnings,	$214.32	-	$222.71	$100.47	$456.86	$300.00	$278.53	$90.00
Unable to work,	1.00	1.00	1.13	1.08	1.97	-	1.00	-
Who own houses,	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Amount of mortgage,	$961.72	-	$1,728.98	$971.43	$1,916.34	-	$973.56	$462.50
Rate of interest,	7.85	-	7.63	8.50	7.64	-	7.79	8.50
Number of rooms hired,	5.05	3.87	3.95	2.48	4.90	4.87	5.31	2.82
Rent paid,	$129.94	$90.71	$163.29	$114.37	$127.99	$118.66	$130.85	$78.82
Value of garden crops,	$19.68	$20.00	$16.00	-	$15.25	-	$35.48	$10.00
Cost of living,	$507.50	$198.32	$549.91	$189.13	$509.30	$217.59	$481.17	$197.30
Number of volumes in library,	144.00	-	165.58	-	258.25	-	179.00	-

* Imperfect, and not tabulated.

Average for each Person answering each Inquiry—Continued.

SCHEDULE QUESTIONS.	LOWELL.		LYNN.		SPRINGFIELD.		TAUNTON.	
	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.
. . . .	2.89	1.44	2.93	1.70	3.03	2.07	3.19	2.65
. . . .	10.13	10.26	10.16	9.75	9.72	10.57	10.12	9.94
. . . .	260.15	250.61	236.69	245.39	266.11	270.53	284.96	225.93
. . . .	$1.97	$0.87	$2.30	$1.02	$1.49	$0.83	$1.91	$0.97
. . . .	$513.35	$221.30	$541.90	$230.84	$603.40	$214.10	$443.78	$217.60
. . . .	$167.19	$90.66	$147.05	$33.57	$187.34	$63.00	$160.53	$176.66
. . . .	$142.77	-	$129.55	-	$120.87	-	$64.25	-
Children's earnings,	$252.51	$102.86	$198.10	$197.33	$359.60	$350.67	$205.36	$300.00
Unable to work,	1.05	1.00	1.33	1.00	1.00	1.00	1.33	1.00
Who own houses,	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Amount of mortgage,	$982.26	$940.00	$1,308.40	$150.00	$1,875.83	$1,700.00	$991.18	-
Rate of interest,	7.25	7.00	8.09	10.00	7.32	6.50	7.00	-
Number of rooms hired,	5.03	2.67	3.27	3.32	5.12	2.96	5.23	5.09
Rent paid,	$113.10	$79.12	$135.80	$101.06	$139.95	$78.91	$108.25	$86.81
Value of garden crops,	$18.14	-	$9.59	-	$18.24	$7.67	$13.88	$15.00
Cost of living,	$497.25	$176.29	$548.55	$214.18	$631.77	$192.39	$517.75	$232.18
Number of volumes in library,	119.43	62.00	132.91	100.00	151.60	-	140.00	-

Average for each Person answering each Inquiry—Concluded.

SCHEDULE QUESTIONS.	Westfield.		Winchendon.		Worcester.	
	Males.	Females.	Males.	Females.	Males.	Females.
	2.84	1.33	2.95	1.75	3.01	1.61
	10.08	10.80	10.48	10.24	10.27	10.36
	261.90	280.81	245.51	233.33	248.61	284.34
	$2.38	$0.87	$1.85	$0.77	$2.31	$0.77
	$648.79	$249.14	$372.98	$159.45	$588.26	$200.40
	$137.42	$15.00	$126.65	-	$179.06	$78.85
	$118.92	-	$128.85	-	$119.41	-
	$210.61	$400.00	$83.95	-	$193.08	$106.33
Unable to work,	1.11	-	1.00	-	1.08	1.00
Who own houses,	1.00	1.00	1.00	-	1.00	1.00
Amount of mortgage,	$1,545.09	$600.00	$724.08	-	$1,554.69	$1,350.00
Rate of interest,	7.36	7.00	7.18	-	7.05	8.25
Number of rooms hired,	4.92	3.73	5.21	-	4.72	3.66
Rent paid,	$136.33	$113.26	$88.40	-	$149.23	$97.48
Value of garden crops,	$9.37	$3.00	$24.52	-	$17.81	$10.00
Cost of living,	$639.13	$243.97	$486.61	$157.80	$587.17	$224.84
Number of volumes in library,	233.88	-	228.37	-	138.05	225.00

CHAPTER V.

Presentation of Twenty Important Occupations, and Exhibit of Averages.

As stated in Chapter I., the whole number of occupations represented by the wage laborers whose returns are tabulated in Part I., is about 950. This number is arrived at, by counting as distinct employments, the various subdivisions of work that are found in such occupations as shoemaking, the making of textile fabrics, etc. It would have been of great value to have tabulated the returns respecting each of these occupations and the branches thereof, separately, but to have done so would have extended our Report considerably beyond the limits which seemed proper to us, and would have involved the exclusion of much of the matter contained in the preceding chapters, unless indeed we had chosen to make it still larger.

Appreciating fully the value of the returns as *connected with occupations*, we have separated from the mass the schedules received from all persons following any one of twenty selected occupations, and tabulated them. The results of that work are shown in the tables of this chapter.

The occupations thus treated are those which the following classes of persons pursue; viz., armorers, blacksmiths, cabinet makers, carpenters, common laborers, curriers, cutlers, chair makers, domestic servants, factory operatives (classified under three general heads,—cotton factory operatives, factory operatives, and woollen factory operatives,—each with subdivisions), farm laborers, jewellery makers, machinists, masons, painters, paper makers, shoemakers (including boot-makers), straw workers, tanners, and whip makers. These occupations, with their subdivisions, amount to about 140 in number. This is about one-fifth the occupations enumerated in Chapter I. The list found there embraces all the employments

and branches of employments followed by the wage laborers of the State, who made returns to this office.

In this tabulation by occupations, only three questions are considered,—the *days employed*, the *yearly wages earned*, and the *cost of living*. Two presentations are made. The first is *by counties*, showing the number of males and of females pursuing each occupation, and the facts respecting the three questions mentioned above; and the second, *by occupations*, showing the number of each sex pursuing each occupation, for the different counties and for the State, and the facts in respect to the three questions with reference to all persons following either of the occupations.

The returns received from operatives employed in cotton and woollen mills, were in such shape as necessitated their being classified under three general heads; viz., *cotton factory operatives*, *woollen factory operatives*, and *factory operatives*, the latter embracing those who failed to mention the material worked upon, but who were supposed to be workers upon either cotton or woollen.

The term *undesignated* appearing among the subdivisions of an occupation, indicates that each person, whose return is so tabulated, entered his or her occupation upon the Individual Schedule, under its general name. For instance, *undesignated*, among shoemakers, indicates those who returned themselves simply as shoemakers without any more particular designation to indicate the branch of the trade followed.

Presentation by Counties.

BARNSTABLE COUNTY.

OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Blacksmiths, ...	M.	7	2,043	7	$4,859	6	$3,190
Carpenters, ...	M.	132	23,780	134	61,998	121	54,126
Common laborers, . .	M.	87	19,223	93	31,163	86	28,577
Curriers, ...	M.	5	1,071	5	1,917	5	1,710
Domestic servants, .	F.	64	14,954	65	6,592	40	4,238
Factory operatives, .	F.	6	1,359	6	835	5	465
Farm laborers, . .	M.	83	18,339	80	21,109	77	23,677
Jewellery maker, . .	M.	1	200	1	400	1	450
Machinists, . . .	M.	6	1,097	6	2,807	5	2,096
Masons, ...	M.	20	3,047	19	8,443	20	8,510
Painters, ...	M.	29	4,416	29	10,567	28	11,160
Shoemakers, . . .	M.	5	1,080	5	2,375	5	2,610
Straw worker, . .	F.	1	136	1	170	1	150

BERKSHIRE COUNTY.

OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Blacksmiths, . . .	M.	25	6,610	27	$13,225	23	$9,765
Cabinet makers, . .	M.	7	1,895	7	3,539	6	3,150
Carpenters, . . .	M.	131	29,305	150	77,984	126	64,826
Chair maker, . . .	M.	1	200	1	300	1	250
Common laborers, . .	M.	257	58,433	266	91,688	210	78,834
Cotton factory operatives:							
Beamer, . . .	M.	1	250	1	500	1	500
Carders, . . .	M.	13	3,050	12	3,100	7	2,600
" . . .	F.	2	580	2	820	1	550
Card grinder, . .	M.	1	300	1	450	1	400
Dressers, . . .	M.	3	862	3	1,777	3	1,750

BERKSHIRE COUNTY—CONTINUED.

OCCUPATIONS.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Cotton factory operatives—*Con.*							
Quiller, . . .	F.	1	234	1	$156	1	$140
Spinners, . . .	M.	11	2,708	10	3,945	5	3,100
"	F.	18	4,345	18	3,495	7	1,055
Spoolers, . . .	F.	15	3,465	15	2,538	5	715
Undesignated, .	M.	13	3,585	18	11,484	17	10,070
Warpers, . . .	F.	2	500	2	560	-	-
Weavers, . .	M.	14	3,164	15	4,702	7	4,850
"	F.	51	12,626	51	12,192	23	4,670
Curriers, . . .	M.	23	6,112	18	9,775	18	8,902
Domestic servants, .	F.	178	54,417	193	25,616	96	11,356
Factory operatives:							
Beamer, . . .	M.	-	-	-	-	1	500
Carders, . . .	M.	4	1,140	5	2,277	3	1,500
Dresser, . . .	M.	1	240	1	450	1	300
Finishers, . .	M.	3	768	3	2,056	3	1,340
Picker tender, . .	M.	1	250	1	265	-	-
Spinners, . . .	M.	5	822	4	869	3	996
Undesignated, .	M.	27	6,751	32	13,425	21	9,737
" . .	F.	9	2,204	9	2,029	7	1,411
Weavers, . .	M.	2	560	3	885	1	220
"	F.	6	1,015	6	981	5	638
Farm laborers, . .	M.	306	72,505	317	93,510	245	76,811
Machinists, . . .	M.	44	11,579	44	28,594	42	24,449
Masons, ...	M.	29	5,640	30	17,367	27	14,755
Painters, . . .	M.	38	7,563	43	18,548	33	16,171
Paper makers:							
Assorter, . . .	M.	-	-	1	350	1	700
"	F.	23	5,198	24	3,918	12	2,821
Calenderers, . .	F.	11	3,027	11	2,214	7	1,820
Engine tenders, .	M.	21	6,089	22	10,792	18	7,062
Finishers, . .	M.	8	2,226	8	3,972	8	3,775

BERKSHIRE COUNTY—CONCLUDED.

OCCUPATIONS.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Paper makers—*Con.*							
Machine tenders, .	M.	10	3,015	10	$5,740	5	$2,850
Rag cutters, . .	M.	4	910	4	1,173	4	1,230
" " . .	F.	37	8,640	37	5,113	27	6,828
Ruler, . . .	M.	1	250	1	700	1	700
Undesignated, .	M.	87	23,796	89	41,370	78	35,973
" . .	F.	43	10,834	47	10,349	28	5,642
Shoemakers:							
Finisher, . . .	M.	1	242	1	384	1	200
Stitchers, . .	F.	2	540	2	810	2	675
Undesignated, .	M.	23	5,148	31	18,549	27	15,544
Tanners, . . .	M.	4	901	4	1,920	3	1,768
Whip makers, . .	M.	4	828	5	2,104	4	1,700
" " . .	F.	2	350	3	362	3	450
Woollen factory operatives:							
Assorters, . .	M.	8	2,184	9	4,873	9	5,150
Carder, . . .	M.	1	100	1	50	-	-
Dressers, . . .	M.	2	508	2	992	2	900
Dyers, . . .	M.	6	1,611	5	2,270	4	1,720
Finishers, . .	M.	4	1,010	4	1,660	4	1,525
" . . .	F.	1	205	1	205	1	205
Fullers, . . .	M.	2	525	2	765	2	405
Giggers, . . .	M.	7	1,355	10	1,961	7	2,720
Loom fixer, . .	M.	1	305	1	672	1	1,000
Picker tender, .	M.	1	300	1	450	1	450
Scourer, . . .	M.	1	100	1	450	1	300
Spinners, . . .	M.	9	2,309	9	3,629	6	2,950
" . . .	F.	2	379	2	359	2	249
Teazle setters, .	M.	2	450	2	400	1	200
Undesignated, .	M.	1	312	1	390	1	720
Weavers, . .	M.	26	7,252	30	14,672	21	11,745
" . . .	F.	20	4,943	22	5,159	11	1,907

BRISTOL COUNTY.

OCCUPATIONS.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Blacksmiths, . . .	M.	43	10,765	43	$23,175	35	$17,957
Cabinet makers, . .	M.	1	200	2	960	1	1,060
Carpenters, . . .	M.	173	36,460	181	97,306	155	83,318
Common laborers, . .	M.	304	66,618	309	112,133	260	122,408
Cotton fact'y operatives:							
Carders, . . .	M.	31	7,349	33	9,516	21	10,218
"	F.	8	1,906	8	1,590	2	508
Card grinders, .	M.	5	1,275	5	1,822	5	2,030
Card strippers, .	M.	2	525	3	982	3	1,270
Cloth trimmer, .	F.	-	-	-	-	1	450
Drawers in, . .	M.	2	450	2	565	2	644
" " . . .	F.	3	590	3	520	1	95
Loom fixers, . .	M.	6	1,400	6	2,809	6	4,187
Overseers, . .	M.	3	880	3	2,123	2	1,050
Picker tenders, .	M.	7	1,673	7	1,950	1	750
Second hand, . . .	M.	1	250	1	500	1	400
Slasher tenders, .	M.	8	1,830	7	3,117	4	434
Speeder tenders, .	F.	25	5,570	25	6,289	4	1,065
Spinners, . .	M.	58	13,723	58	23,708	48	22,416
"	F.	20	4,978	23	4,878	1	300
Spoolers, . .	M.	9	2,000	9	3,295	4	1,595
"	F.	19	4,301	18	2,950	4	1,042
Undesignated, .	M.	6	1,375	7	2,229	6	1,835
" .	F.	1	150	1	120	-	-
Warper, . . .	F.	1	260	1	234	-	-
Weavers, . .	M.	156	35,215	157	53,945	90	34,502
"	F.	110	24,002	112	30,413	43	11,753
Winders, . . .	M.	-	-	-	-	2	400
Curriers, ...	M.	3	690	3	2,165	3	1,000
Cutlers, ...	M.	4	754	4	1,183	3	1,250

BRISTOL COUNTY—CONTINUED.

OCCUPATIONS.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Domestic servants,	F.	322	107,384	383	$62,132	229	$29,910
Factory operatives:							
Carders,	M.	11	2,625	11	4,113	10	4,346
"	F.	5	1,010	6	1,358	3	632
Card grinders,	M.	6	1,590	6	2,337	3	1,550
Card stripper,	M.	1	150	1	187	-	-
Cloth trimmers,	F.	10	2,209	12	2,813	8	2,142
Doffer,	M.	1	110	1	110	-	-
Drawer in,	M.	1	313	1	400	1	390
" "	F.	32	7,243	32	7,440	16	3,161
Dyer,	M.	1	150	1	114	1	100
Loom fixers,	M.	22	5,465	23	10,583	18	9,042
Mule spinners,	M.	17	3,448	19	6,355	11	4,887
Overseers,	M.	3	712	3	2,187	3	2,020
Second hands,	M.	9	1,965	11	7,066	9	5,160
Speeder tenders,	M.	7	1,860	7	2,051	1	450
" "	F.	28	6,760	29	6,880	11	1,793
Spinner,	M.	1	200	1	300	1	300
"	F.	16	3,573	16	3,689	10	1,885
Spoolers,	M.	2	450	2	535	-	-
"	F.	26	6,085	26	5,106	8	1,187
Undesignated,	M.	26	6,263	28	11,282	22	12,153
"	F.	33	7,546	33	7,322	18	4,745
Warpers,	F.	12	2,825	11	2,620	7	1,302
Weavers,	M.	36	8,702	39	13,468	29	13,775
"	F.	142	33,316	146	43,443	78	17,294
Farm laborers,	M.	187	42,992	188	56,619	137	41,360
Jewellery makers,	M.	418	83,936	425	196,236	331	161,269
Machinists,	M.	84	20,833	88	55,098	71	43,000
Masons,	M.	71	11,602	75	35,165	71	34,869
Painters,	M.	53	11,413	54	27,306	48	24,008

BRISTOL COUNTY—CONCLUDED.

OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Shoemakers:							
Bottomers,	M.	4	667	4	$1,617	4	$1,880
Cutters,	M.	11	2,404	12	5,959	10	4,858
Finishers,	M.	2	475	2	1,125	2	1,000
Lasters,	M.	8	1,480	8	2,292	8	2,908
McKay stitcher,	M.	1	150	1	187	-	-
Nailers,	M.	5	748	7	2,096	6	1,600
Pegger,	M.	1	100	1	350	1	350
Undesignated,	M.	74	13,803	81	29,923	72	32,020
Straw workers:							
Presser,	F.	1	80	1	80	1	80
Sewers,	F.	14	2,273	17	1,714	5	455
Wirers,	F.	2	300	3	400	-	-
Tanner,	M.	1	260	1	520	1	500
Woollen factory operatives:							
Assorters,	M.	2	375	3	1,587	3	1,450
Carder,	M.	-	-	1	528	1	528
Finisher,	M.	1	300	1	900	1	1,100
Undesignated,	M.	2	500	2	834	2	1,440
Weaver,	M.	1	280	1	420	1	420

DUKES COUNTY.

OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Blacksmiths,	M.	4	950	4	$1,824	4	$1,875
Carpenters,	M.	47	6,813	50	20,228	48	20,710
Common laborers,	M.	36	6,364	42	12,200	36	12,262
Domestic servants,	F.	2	565	2	482	-	-
Farm laborers,	M.	21	4,647	22	4,871	19	5,875
Machinist,	M.	1	25	1	75	1	150
Masons,	M.	3	285	3	975	3	1,450
Painters,	M.	10	1,515	11	5,170	12	5,675
Shoemakers,	M.	5	1,050	5	1,242	5	1,600

ESSEX COUNTY.

OCCUPATIONS.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Blacksmiths, . . .	M.	68	17,675	69	$39,163	51	$27,379
Cabinet makers, . .	M.	46	10,523	48	23,064	37	19,209
Carpenters, . . .	M.	399	87,237	409	218,566	346	186,912
Chair makers, . .	M.	6	1,355	6	1,907	5	1,665
Common laborers, . .	M.	412	95,003	421	151,006	312	131,528
Cotton factory operatives:							
Carders, . . .	M.	18	4,286	19	6,453	14	5,969
" . . .	F.	14	3,421	12	3,051	7	1,249
Card strippers, .	M.	2	400	2	450	2	682
Dressers, . . .	F.	2	553	2	1,043	2	1,137
Finishers, . .	M.	7	1,839	7	2,468	5	1,940
Picker tenders, .	M.	7	1,590	7	1,647	6	3,060
" " . .	F.	41	9,216	39	9,091	31	6,163
Slasher tender, .	M.	1	300	1	500	1	300
Spinners, . . .	M.	14	3,928	14	7,334	14	6,894
" . . .	F.	6	1,809	6	1,632	4	795
Undesignated, .	M.	15	4,210	14	6,242	11	4,585
Weavers, . .	M.	36	7,895	33	9,767	21	8,260
Curriers:							
Finishers, . .	M.	18	4,704	21	9,940	12	6,855
Morocco dressers, .	M.	35	9,166	37	21,929	22	11,754
Undesignated, .	M.	84	20,437	92	40,718	47	21,022
Domestic servants, .	F.	499	161,387	545	90,342	215	30,191
Factory operatives:							
Carders, . . .	M.	5	1,407	5	3,550	4	2,837
" . . .	F.	4	1,080	4	957	5	1,489
Drawers in, . .	F.	17	4,212	14	2,874	8	1,754
Dressers, . . .	M.	9	2,232	6	2,276	5	2,453
Folders, . . .	F.	4	844	3	640	2	450
Harness makers, .	F.	8	1,956	9	2,279	5	940

ESSEX COUNTY—Continued.

OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Fact'y operatives—*Con.*							
Loom fixers, . .	M.	5	1,450	4	$2,260	5	$2,590
Mule spinners, .	M.	10	2,466	8	2,976	6	2,086
Oilers, . . .	M.	3	606	3	835	3	1,310
Packer, . . .	M.	1	250	1	250	1	185
Scourer, . . .	M.	1	270	1	467	1	450
Section hands, .	M.	4	982	3	1,450	2	920
Slasher tender, .	M.	1	262	1	487	1	551
Spinners, . . .	M.	17	4,307	17	8,863	17	8,927
" . . .	F.	37	8,942	35	8,617	8	1,731
Spoolers, . . .	F.	43	10,418	45	8,919	15	2,547
Undesignated, .	M.	191	47,667	187	70,989	126	60,083
" .	F.	91	19,891	79	15,874	70	12,992
Warpers, . . .	F.	11	2,329	10	2,279	9	1,984
Weavers, . .	M.	49	11,721	55	14,302	31	9,602
" . . .	F.	157	35,119	142	33,770	108	24,593
Farm laborers, . .	M.	329	82,000	336	115,357	219	77,479
Jewellery maker, . .	M.	1	300	1	600	1	600
Machinists, . . .	M.	135	36,776	133	80,058	102	59,309
Masons, ...	M.	101	17,942	101	52,926	84	43,539
Painters, . . .	M.	108	22,445	109	51,753	77	36,387
Paper makers:							
Undesignated, .	M.	4	900	3	1,997	3	2,100
" .	F.	1	237	1	237	-	-
Shoemakers:							
Beaters out, . .	M.	11	2,368	12	5,521	9	3,840
Binders, . . .	F.	3	700	3	500	3	900
Bottomers, . .	M.	19	5,688	18	9,098	15	7,891
Buffers, . . .	M.	6	1,305	6	3,055	4	2,104
Burnishers, . .	M.	3	745	4	1,750	3	836
Channellers, . .	M.	11	2,324	11	4,447	8	4,450

ESSEX COUNTY—CONTINUED.

OCCUPATIONS.	SEX.	DAYS EMPLOYED. Number answering.	DAYS EMPLOYED. Aggregate.	YEARLY WAGES. Number answering.	YEARLY WAGES. Aggregate.	COST OF LIVING. Number answering.	COST OF LIVING. Aggregate.
Shoemakers—*Con.*							
Crimpers, . . .	M.	3	770	3	$1,200	3	$1,450
Cutters, . . .	M.	254	61,745	267	139,226	205	120,122
" . . .	F.	1	260	1	260	1	200
Dressers, . . .	M.	14	3,318	15	6,759	11	6,760
Edge setters, . .	M.	19	4,244	21	8,937	17	7,527
Eyeleters, . .	F.	4	887	4	1,437	4	906
Finishers, . .	M.	50	11,282	51	23,580	39	18,566
" . . .	F.	5	1,080	5	1,390	5	1,075
Fitters, . . .	M.	34	9,594	35	19,129	23	12,727
" . . .	F.	5	1,176	5	1,375	3	830
Heelers, . . .	M.	74	16,599	77	37,353	54	26,552
Lasters, . . .	M.	94	19,968	99	43,682	72	31,387
" . . .	F.	5	920	7	1,404	2	508
Packers, . . .	M.	9	2,100	8	3,324	5	1,607
Pasters, . . .	F.	17	3,451	17	4,557	8	2,125
Peggers, . . .	M.	11	2,623	13	6,861	10	6,514
Pressers, . . .	F.	3	451	3	388	2	172
Rosette makers, .	F.	4	950	4	1,135	1	210
Stitchers, . . .	M.	44	10,586	45	23,336	29	15,831
" . . .	F.	163	32,887	176	47,523	81	20,837
Treers, . . .	M.	4	1,100	4	2,050	4	1,925
Trimmers, . .	M.	32	7,635	34	17,278	30	16,130
" . . .	F.	31	6,480	33	9,218	13	4,930
Undesignated, .	M.	883	206,844	921	385,606	696	317,842
" .	F.	14	3,085	13	2,984	5	960
Welters, . . .	M.	2	500	2	875	2	875
Tanners:							
Dressers, . . .	M.	3	550	4	1,323	2	673
Finishers, . .	M.	2	400	3	1,200	1	750
Undesignated, .	M.	27	6,046	34	14,061	19	9,306

ESSEX COUNTY—Concluded.

OCCUPATIONS.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Woollen factory operatives:							
Assorters, . .	M.	48	12,422	47	$20,090	31	$15,375
Burlers, . . .	F.	2	463	2	492	1	112
Carders, . . .	M.	3	762	3	2,536	3	2,536
Combers, . .	M.	3	870	3	1,635	2	474
Dressers, . . .	M.	10	2,189	8	4,002	6	3,317
Dyers, . . .	M.	22	5,327	18	7,668	18	8,113
Fuller, . . .	M.	1	308	1	372	-	-
Giggers, . . .	M.	9	2,462	9	3,127	4	3,218
Loom fixers, . .	M.	3	830	3	1,588	2	1,080
Oiler, . . .	M.	1	350	-	-	1	880
Picker tenders, .	M.	3	813	4	700	-	-
Reelers, . . .	F.	10	2,749	7	1,909	9	2,066
Scourer, . . .	M.	1	312	1	441	-	-
Spinners, . .	M.	20	4,241	19	5,385	12	5,370
" . . .	F.	1	260	1	260	1	260
Twisters, . . .	M.	5	1,116	4	1,195	3	1,066
" . . .	F.	1	208	1	180	1	180
Weavers, . .	M.	31	8,119	33	11,723	18	6,408
" . . .	F.	43	10,976	41	10,784	30	6,390

FRANKLIN COUNTY.

Blacksmiths, . . .	M.	23	5,402	23	$12,654	17	$8,884
Cabinet makers, . .	M.	15	3,537	16	6,299	12	4,297
Carpenters, . . .	M.	93	19,970	97	49,152	84	38,456
Chair makers, . .	M.	15	3,943	14	6,550	11	4,254
Common laborers, . .	M.	71	16,058	74	25,303	49	19,736
Cotton factory operatives:							
Carder, . . .	M.	1	300	1	249	1	156
Dressers, . . .	M.	2	510	2	1,225	2	880

FRANKLIN COUNTY—CONTINUED.

OCCUPATIONS.	SEX.	DAYS EMPLOYED.		YEARLY WAGES.		COST OF LIVING.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Cotton factory operatives—*Con.*							
Overseers, . .	M.	2	585	2	$1,462	2	$1,200
Speeder tender, .	M.	1	286	1	430	1	600
" " .	F.	3	675	3	588	2	426
Spinners, . . .	M.	4	1,055	4	1,666	3	1,400
Spooler, . . .	F.	1	275	1	247	-	-
Weavers, . .	M.	4	1,090	4	1,284	2	382
"	F.	17	3,734	17	3,938	8	1,348
Cutlers:							
Blade oiler, . .	M.	1	260	1	260	1	260
Bolster dropper, .	M.	1	250	1	500	1	500
Finishers, . .	M.	17	3,646	17	5,897	17	6,985
Forgers, . . .	M.	3	590	4	1,725	4	1,740
Grinders, . .	M.	35	7,301	35	13,246	23	14,627
Hafters, . . .	M.	2	394	2	716	2	1,360
Handle riveter, .	M.	1	150	1	300	1	375
Handle sawyers, .	M.	2	520	2	1,177	2	1,370
Knife cleaners, .	F.	2	460	2	460	2	340
Polisher, . . .	M.	1	225	1	394	1	394
Temperer, . .	M.	1	208	1	512	1	1,024
Undesignated, .	M.	120	28,390	126	55,694	99	47,535
Domestic servants, .	F.	128	35,981	142	19,387	57	7,061
Factory operatives:							
Undesignated, .	M.	14	3,060	14	5,513	11	4,152
" . .	F.	3	790	3	600	3	480
Weaver, . . .	F.	1	106	1	128	-	-
Farm laborers, . .	M.	162	38,149	160	44,235	124	37,446
Machinists, . . .	M.	48	12,225	51	32,164	41	24,643
Masons, ...	M.	27	4,959	29	13,467	23	12,383
Painters, . . .	M.	37	7,897	36	17,010	32	14,052

FRANKLIN COUNTY—CONCLUDED.

OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Paper makers:							
Assorter, . . .	F.	1	200	1	$200	-	-
Undesignated, .	M.	40	10,816	37	18,985	20	$10,775
" . .	F.	39	9,996	35	9,786	15	4,005
Shoemakers:							
Bottomers, . .	M.	9	2,045	10	2,802	9	2,648
Cutters, . . .	M.	2	550	2	687	2	600
Finisher, . . .	M.	-	-	1	375	1	375
Stitcher, . . .	M.	1	240	1	300	1	208
" . . .	F.	2	550	2	619	1	200
Treer, . . .	M.	1	260	1	500	1	450
Undesignated, .	M.	15	3,480	15	5,500	13	4,136
Tanner, ...	M.	1	300	1	465	1	300
Woollen factory operatives:							
Assorters, . .	M.	2	600	2	705	1	200
Carders, . . .	M.	3	468	3	574	-	-
Dressers, . . .	M.	2	575	2	1,012	2	1,000
Dyer, . . .	M.	1	250	1	500	1	400
Finisher, . . .	M.	1	300	1	600	1	600
Loom fixer, . .	M.	1	300	1	600	-	-
Picker tender, .	M.	1	300	1	375	1	400
Spinners, . .	M.	4	1,200	4	1,825	4	1,575
Weavers, . .	M.	9	2,475	9	3,517	4	1,175
" . . .	F.	1	300	1	225	1	200

HAMPDEN COUNTY.

OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Armorers, . . .	M.	221	58,954	227	$164,778	231	$161,339
Blacksmiths, . . .	M.	72	19,417	71	34,818	58	26,329
Cabinet makers, . .	M.	5	1,396	6	4,616	5	3,258
Carpenters, . . .	M.	396	94,150	402	227,779	315	178,160

HAMPDEN COUNTY—CONTINUED.

OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Common laborers, . .	M.	249	60,295	257	$98,583	196	$98,430
Cotton factory operatives:							
Carders, . . .	M.	32	8,491	32	16,580	21	11,826
" . . .	F.	33	8,349	32	7,368	7	1,199
Card grinders, .	M.	3	870	3	1,155	2	865
Card strippers, .	M.	2	580	2	571	-	-
Cloth trimmers, .	F.	2	350	2	320	1	150
Dressers, . . .	M.	14	3,747	15	7,984	12	6,638
Dyer, . . .	M.	1	313	1	500	1	500
Finishers, . .	M.	2	544	2	1,779	2	1,700
Folder, . . .	M.	1	300	1	675	-	-
" . . .	F.	3	625	3	562	2	275
Inspectors, . .	F.	2	560	2	435	2	350
Loom fixers, . .	M.	5	1,196	5	1,817	5	1,815
Picker tenders, .	M.	4	1,160	4	1,170	3	975
" " .	F.	3	740	3	630	2	410
Section hand, . .	M.	1	225	1	450	1	500
Spinners, . . .	M.	40	10,698	40	21,270	33	16,351
" . . .	F.	28	6,231	27	8,324	25	4,539
Spoolers, . . .	M.	5	2,281	5	2,406	5	3,294
" . . .	F.	9	2,456	9	2,309	8	1,275
Undesignated, .	M.	7	2,040	8	3,878	3	1,475
Weavers, . .	M.	5	1,292	5	2,214	4	1,900
" . . .	F.	188	44,745	188	53,186	154	39,775
Currier, ...	M.	1	313	1	420	1	420
Domestic servants, .	F.	300	94,088	308	48,661	179	23,672
Factory operatives:							
Carders, . . .	M.	14	3,885	14	4,633	5	2,800
" . . .	F.	30	7,270	30	5,439	9	1,500
Card grinder, . .	M.	-	-	1	438	1	438
Dressers, . . .	M.	3	800	3	710	-	-

HAMPDEN COUNTY—Continued.

OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Fact'y operatives—*Con.*							
Dyer,	M.	1	290	1	$725	1	$600
Finisher,	M.	1	40	1	40	-	-
Folder,	M.	1	160	1	160	-	-
Fuller,	M.	1	249	1	403	1	386
Loom fixers,	M.	10	2,665	11	4,767	6	2,823
Measurer,	M.	1	300	1	525	1	525
Overseers,	M.	4	1,182	4	3,358	3	2,000
Picker tenders,	M.	6	1,700	6	1,996	5	3,700
Spinners,	M.	22	5,608	21	8,549	7	3,500
"	F.	20	5,275	20	3,733	2	475
Spoolers,	F.	7	1,696	7	1,340	3	693
Undesignated,	M.	44	11,141	43	813	30	15,716
"	F.	30	7,155	28	5,320	10	1,884
Warpers,	F.	3	900	3	810	1	200
Weavers,	M.	47	12,131	46	13,447	21	6,764
"	F.	93	22,463	92	20,136	8	1,760
Farm laborers,	M.	273	67,328	280	93,456	180	62,243
Jewellery makers,	M.	8	2,212	9	5,514	6	3,487
Machinists,	M.	194	51,919	188	133,999	169	111,647
Masons,	M.	99	19,056	97	53,596	71	38,494
Painters,	M.	101	22,459	106	51,493	77	36,924
Paper makers:							
Assorters,	F.	8	1,840	8	2,463	5	1,369
Finishers,	M.	5	1,463	5	3,588	4	2,022
"	F.	11	2,408	11	3,081	11	2,892
Machine tenders,	M.	5	1,477	5	4,224	4	3,626
" "	F.	1	175	1	437	-	-
Packer,	M.	1	280	1	700	1	700
Ragcutters,	F.	13	2,471	12	2,141	7	1,564
Rulers,	F.	4	988	6	1,732	-	-

HAMPDEN COUNTY—Continued.

OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Paper makers—*Con.*							
Undesignated,	M.	78	21,194	79	$49,357	60	$38,522
"	F.	22	4,839	22	5,988	9	2,093
Shoemakers,	M.	19	5,095	19	8,519	18	8,165
Straw workers:							
Bleacher,	M.	-	-	-	-	1	500
Blocker,	M.	1	200	1	500	1	575
Finishers,	M.	5	1,044	5	3,423	3	2,350
Machine sewers,	F.	2	342	2	527	1	275
Overseers,	M.	2	570	2	2,607	2	2,600
Pressers,	M.	4	776	4	1,891	4	2,850
Sewers,	F.	20	2,681	20	4,218	14	3,055
Trimmers,	F.	6	921	6	1,249	4	802
Undesignated,	M.	5	1,025	5	2,516	2	1,737
"	F.	18	2,590	18	3,494	10	1,760
Wirer,	F.	1	40	1	30	-	-
Tanners,	M.	8	2,326	8	4,262	7	3,556
Whip makers,	M.	119	29,934	121	68,164	68	39,253
Woollen factory operatives:							
Assorters,	M.	7	1,372	7	2,622	6	3,050
Burler,	M.	1	220	1	176	-	-
"	F.	7	1,915	7	1,815	6	1,388
Carders,	M.	6	1,683	6	3,596	6	3,625
Drawer in,	F.		-	1	240	1	150
Dressers,	M.	4	1,123	4	1,866	4	1,642
Dyers,	M.	9	2,600	9	5,015	4	2,750
Finishers,	M.	10	2,646	10	4,556	5	2,120
Giggers,	M.	5	1,490	5	2,216	2	586
Overseers,	M.	1	287	2	1,525	2	1,150
Picker tender,	M.	-	-	1	400	1	300
Scourer,	M.	1	300	1	450	1	450

HAMPDEN COUNTY—CONCLUDED.

OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Woollen factory operatives—*Con.*							
Shearers, . . .	M.	3	878	3	$1,322	1	$240
Spinners, . . .	M.	12	2,767	12	4,689	9	3,450
"	F.	1	250	1	225	1	225
Spoolers, . . .	F.	2	576	2	394	1	150
Undesignated, .	M.	18	3,919	18	6,445	14	4,917
" . .	F.	5	1,253	5	1,233	2	386
Weavers, . . .	M.	19	4,639	19	7,488	14	6,046
"	F.	21	5,050	19	5,214	13	3,114

HAMPSHIRE COUNTY.

OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Armorers, . . .	M.	17	4,432	16	$7,555	12	$5,759
Blacksmiths, . . .	M.	5	1,218	5	3,250	5	2,250
Cabinet maker, . .	M.	1	205	1	615	1	639
Carpenters, . . .	M.	62	13,647	65	32,322	44	20,915
Common laborer, . .	M.	65	13,012	63	19,748	44	16,676
Cotton factory operatives:							
Carders, . . .	F.	5	1,050	6	1,174	2	437
Finishers, . .	M.	3	913	3	1,680	-	-
Weavers, . .	F.	2	560	4	1,045	-	-
Cutlers, ...	M.	21	5,031	20	11,300	19	9,898
Domestic servants, .	F.	116	34,494	119	17,265	51	6,179
Factory operatives:							
Finisher, . . .	M.	1	240	1	180	1	180
Loom fixer, . .	M.	1	275	1	483	1	400
Spinners, . . .	M.	3	670	3	1,396	2	933
Undesignated, .	M.	2	340	2	733	2	863
" .	F.	12	2,976	12	3,326	10	2,006
Weavers, . . .	M.	4	1,029	4	2,158	3	2,072
" . .	F.	5	930	5	1,122	2	625

HAMPSHIRE COUNTY—CONCLUDED.

OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Farm laborers, . .	M.	290	66,483	299	$84,316	214	$63,504
Machinists, . . .	M.	31	7,204	31	18,380	23	14,996
Masons, ...	M.	25	4,357	26	12,820	21	9,416
Painters, . . .	M.	16	3,139	16	7,241	12	5,211
Paper makers:							
Assorters, . .	F.	2	400	2	450	2	450
Calenderer, . .	F.	1	250	1	375	1	375
Machine tender, .	M.	1	326	1	815	1	525
Size maker, . .	M.	1	225	1	450	1	500
Undesignated, .	M.	36	9,552	37	17,729	29	13,585
" .	F.	22	5,163	22	4,704	12	2,606
Shoemakers, . . .	M.	5	1,375	5	2,300	4	1,850
Whip makers, . .	M.	2	450	2	675	-	-
Woollen factory operatives:							
Assorter, . . .	M.	1	160	1	360	1	350
Fuller, . . .	M.	1	312	1	546	1	450

MIDDLESEX COUNTY.

OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Blacksmiths, . . .	M.	114	29,740	117	$70,772	100	$55,369
Cabinet makers, . .	M.	74	18,499	77	45,162	60	34,023
Carpenters, . . .	M.	886	199,401	894	502,378	724	394,778
Chair makers, . .	M.	27	6,432	27	12,132	21	9,243
Common laborers, . .	M.	1,260	284,871	1,285	482,719	1,080	457,992
Cotton factory operatives:							
Assorter, . . .	M.	1	300	1	600	-	-
Carders, . . .	M.	79	21,304	79	37,718	67	30,579
"	F.	74	18,914	67	15,198	58	10,095
Card grinders, .	M.	5	1,350	5	2,168	4	1,275
Card strippers, .	M.	5	1,197	4	1,245	4	1,244
" " . .	F.	1	300	1	300	1	300

MIDDLESEX COUNTY—CONTINUED.

OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Cotton factory operatives—*Con.*							
Dressers,	M.	3	700	3	$1,010	2	$600
"	F.	5	1,300	5	1,300	-	-
Dyers,	M.	6	1,445	6	3,235	5	2,379
Finishers,	M.	3	485	3	785	3	1,160
"	F.	2	350	2	313	2	277
Folders,	F.	3	854	3	875	2	395
Loom fixers,	M.	4	944	4	1,679	4	2,025
Mule spinners,	M.	3	875	3	1,722	3	1,200
Oilers,	M.	10	1,009	4	1,339	3	1,540
Packer,	F.	1	200	1	144	-	-
Picker tenders,	M.	11	2,853	11	4,480	8	3,996
Slasher tenders,	M.	6	1,806	6	3,284	5	2,351
Speeder tender,	F.	1	270	1	297	1	297
Spinners,	M.	79	21,120	76	38,345	64	30,087
"	F.	130	32,642	127	26,131	102	17,916
Spooler,	M.	1	313	1	406	1	450
"	F.	82	19,459	85	16,593	47	8,094
Undesignated,	M.	9	2,335	10	4,007	6	2,550
"	F.	7	1,326	7	1,132	4	695
Warpers,	F.	20	5,470	21	5,000	15	2,615
Weavers,	M.	75	20,155	72	33,533	59	24,350
"	F.	602	146,228	601	142,464	481	89,779
Web drawers,	F.	30	7,126	29	6,325	26	4,101
Winders,	F.	2	588	1	293	-	-
Curriers:							
Beamsters,	M.	-	-	2	520	2	520
Buffer,	M.	1	310	1	620	1	500
Finishers,	M.	19	4,496	19	8,910	18	6,651
Measurers,	M.	2	599	3	2,376	3	2,500
Scourer,	M.	1	325	1	487	1	500

MIDDLESEX COUNTY—CONTINUED.

OCCUPATIONS.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Curriers—*Con.*							
Splitters, . . .	M.	6	1,622	6	$5,923	6	$3,680
Stuffers, . . .	M.	7	1,648	7	3,158	6	2,725
Tablemen, . .	M.	10	2,211	9	3,922	8	2,950
Undesignated, .	M.	437	107,659	446	206,421	417	195,062
Domestic servants, .	F.	1,551	494,464	1,648	277,122	845	115,270
Factory operatives:							
Carders, . . .	M.	4	1,100	3	1,275	3	1,245
Card grinders, .	M.	6	1,519	6	2,258	5	2,305
Card strippers, .	M.	4	984	4	1,224	4	1,532
Folders, . . .	F.	18	4,186	18	4,134	11	2,382
Loom fixers, . .	M.	15	4,175	12	6,765	13	6,164
Mule spinners, .	M.	4	890	4	1,105	3	860
Packer, . . .	M.	1	287	1	575	1	700
Presser, . . .	M.	1	300	1	330	1	500
Spinner, . . .	F.	1	231	1	287	1	287
Spoolers, . . .	F.	3	420	3	222	3	222
Stitchers . . .	F.	2	320	2	320	-	-
Undesignated, .	M.	60	14,312	60	20,663	38	15,432
" . .	F.	39	8,493	37	8,939	23	4,807
Warper, . . .	F.	1	249	1	230	-	-
Weavers, . .	F.	51	11,706	52	12,842	31	7,736
Farm laborers, . .	M.	609	151,350	629	212,700	433	165,063
Jewellery makers, . .	M.	5	1,102	5	1,949	4	1,995
" " . .	F.	3	776	3	643	3	793
Machinists, . . .	M.	442	113,967	437	265,897	371	219,634
Masons, ...	M.	220	41,675	234	125,451	197	106,368
Painters, . . .	M.	237	52,231	239	124,138	196	102,682
Paper makers:							
Assorter, . . .	M.	1	150	1	150	-	-
"	F.	4	725	4	558	1	75
Bleacher, . .	F.	-	-	1	150	-	-

MIDDLESEX COUNTY—Continued.

OCCUPATIONS.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Paper makers—*Con.*							
Boiler tenders,	M.	4	700	4	$1,264	-	-
Cutter tenders,	F.	4	925	5	1,202	2	$600
Dyer,	M.	-	-	1	200	-	-
Finishers,	M.	2	463	3	1,560	2	1,075
"	F.	2	250	2	235	-	-
Machine tenders,	M.	8	2,045	8	4,912	4	2,150
Undesignated,	M.	51	12,754	53	27,602	38	17,643
"	F.	5	1,022	5	879	3	537
Shoemakers:							
Bottomers,	M.	10	2,081	10	4,162	5	3,602
Buffers,	M.	4	846	7	2,439	3	1,437
Burnishers,	M.	11	2,163	11	4,198	4	1,716
"	F.	1	280	1	280	-	-
Crimpers,	M.	9	1,900	9	3,806	6	2,930
Cutters,	M.	171	39,133	174	97,338	148	81,678
Dressers,	M.	11	2,366	11	4,852	10	5,020
"	F.	3	650	5	1,190	1	160
Eyeleters,	F.	10	1,742	11	1,817	5	1,283
Finishers,	M.	111	23,841	116	54,087	102	53,794
"	F.	1	150	1	150	1	75
Fitters,	M.	13	3,027	13	6,094	11	5,804
"	F.	13	2,746	13	3,611	8	2,104
Heelers,	M.	44	9,573	48	24,856	35	18,233
"	F.	6	1,592	7	2,414	4	1,136
Lasters,	M.	101	19,153	107	40,930	83	37,315
"	F.	1	260	1	325	1	325
Levellers,	M.	8	1,681	7	3,055	6	3,935
Packers,	M.	12	2,668	12	5,849	12	5,658
Pasters,	F.	12	2,155	12	2,345	8	1,964
Peggers,	M.	26	5,879	30	18,326	26	15,314
Pressers,	M.	3	809	3	2,273	3	2,283

MIDDLESEX COUNTY—Continued.

Occupations.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Shoemakers—*Con.*							
Sand-paperers,	M.	4	950	4	$1,925	2	$1,100
Siders,	M.	2	533	2	891	2	850
Skivers,	M.	2	400	1	450	2	950
"	F.	2	369	2	350	2	185
Stitchers,	M.	13	2,853	13	5,425	10	3,220
"	F.	109	22,737	112	30,762	62	19,099
Stringers,	F.	4	735	4	509	-	-
Treers,	M.	19	4,255	19	8,900	14	6,650
Trimmers,	M.	54	11,121	58	26,598	49	26,803
"	F.	6	1,255	6	1,346	3	885
Undesignated,	M.	645	141,939	699	287,367	537	234,432
"	F.	78	15,101	80	15,474	40	10,737
Straw workers:							
Presser,	M.	1	50	1	150	1	500
Sewer,	F.	1	75	1	75	1	75
Trimmers,	F.	2	369	2	550	-	-
Undesignated,	M.	5	1,216	5	2,819	3	2,019
"	F.	5	925	6	856	1	200
Tanners:							
Beamsters,	M.	7	2,052	7	3,434	6	3,342
Undesignated,	M.	61	16,143	63	32,114	60	33,281
Woollen factory operatives:							
Assorters,	M.	43	11,279	46	20,561	38	18,193
Carders,	M.	25	6,340	25	11,293	17	8,901
Dressers,	M.	8	2,118	9	4,087	7	3,144
"	F.	1	240	2	490	1	300
Dyers,	M.	48	11,699	45	26,886	36	21,494
Finishers,	M.	15	3,615	15	5,211	9	2,650
"	F.	2	300	1	75	2	275
Folders,	F.	2	490	2	441	2	300

MIDDLESEX COUNTY—CONCLUDED.

OCCUPATIONS.	SEX.	DAYS EMPLOYED. Number answering.	DAYS EMPLOYED. Aggregate.	YEARLY WAGES. Number answering.	YEARLY WAGES. Aggregate.	COST OF LIVING. Number answering.	COST OF LIVING. Aggregate.
Woollen factory operatives—*Con.*							
Giggers, . . .	M.	2	500	2	$616	1	$300
Picker tenders, .	M.	5	1,291	5	3,212	4	1,935
Pressers, . . .	F.	4	1,045	4	1,124	3	736
Reelers, . . .	F.	5	1,350	8	1,946	6	1,075
Scourers, . . .	M.	5	1,374	4	1,415	4	1,734
Spinners, . . .	M.	64	12,798	60	23,097	45	23,429
" . . .	F.	4	992	4	800	-	-
Spoolers, . . .	M.	2	148	2	53	2	60
Stitchers, . .	F.	60	14,725	64	16,218	61	11,277
Twisters, . . .	F.	2	442	2	602	-	-
Undesignated, . .	M.	56	13,037	54	19,464	45	16,929
" . . .	F.	22	4,780	22	4,637	14	2,309
Warper, . . .	F.	1	225	1	225	1	225
Weavers, . . .	M.	36	9,915	46	15,813	29	14,397
" . . .	F.	133	29,901	127	26,889	82	14,756

NANTUCKET COUNTY.

Common laborers, .	M.	6	1,420	6	$1,850	1	$365
Domestic servants, .	F.	8	2,710	8	864	2	155
Straw workers:							
Sewers, . . .	F.	2	160	2	130	2	170

NORFOLK COUNTY.

Blacksmiths, . . .	M.	48	11,328	48	$24,874	39	$21,820
Cabinet makers, . .	M.	17	4,076	17	10,201	13	8,355
Carpenters, . . .	M.	256	55,787	266	144,717	213	114,588
Chair maker, . . .	M.	1	200	1	250	-	-
Common laborers, .	M.	459	99,242	479	154,498	356	148,474

NORFOLK COUNTY—Continued.

OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Cotton factory operatives:							
Carders, . . .	M.	2	463	2	$832	1	$300
Card grinder, . .	M.	1	300	1	500	-	-
Dressers, . . .	M.	2	550	2	1,000	2	1,300
Mule spinner, . .	M.	1	312	1	499	1	540
Overseers, . .	M.	2	498	2	1,294	1	750
Speeder tenders, .	F.	3	790	2	497	-	-
Spinners, . . .	M.	6	1,553	5	1,449	3	1,128
" . . .	F.	2	600	2	394	1	250
Spooler, . . .	F.	1	175	1	105	-	-
Undesignated, .	M.	5	1,192	5	1,669	5	2,275
Warpers, . . .	F.	4	800	4	804	2	564
Weavers, . . .	M.	7	1,020	5	817	1	150
" . . .	F.	3	750	3	975	3	636
Curriers, . . .	M.	17	3,762	16	8,374	10	5,447
Domestic servants, .	F.	212	68,066	249	37,292	96	13,939
Factory operatives:							
Carders, . . .	M.	9	2,534	10	3,927	7	2,722
Card inspector, .	F.	-	-	1	300	1	300
Dressers, . . .	M.	2	542	2	915	1	725
Dyers, . . .	M.	2	347	2	1,000	1	400
Loom fixers, . .	M.	2	525	2	974	2	1,204
Overseer, . .	M.	1	300	1	600	1	300
Spinners, . .	M.	5	1,250	4	1,875	4	2,225
" . .	F.	1	250	1	280	1	130
Spoolers, . . .	F.	4	903	4	886	4	922
Undesignated, .	M.	18	4,842	18	9,523	16	8,491
" .	F.	5	1,266	4	770	-	-
Weavers, . .	M.	10	2,351	10	3,909	9	3,709
" . .	F.	2	400	2	700	2	320
Farm laborers, . .	M.	202	48,885	210	74,864	167	65,146

NORFOLK COUNTY—CONTINUED.

OCCUPATIONS.	SEX.	DAYS EMPLOYED. Number answering.	DAYS EMPLOYED. Aggregate.	YEARLY WAGES. Number answering.	YEARLY WAGES. Aggregate.	COST OF LIVING. Number answering.	COST OF LIVING. Aggregate.
Jewellery makers, . .	M.	21	4,676	31	$17,815	21	$13,448
" " . .	F.	1	200	1	270	1	300
Machinists, . . .	M.	77	21,153	79	57,689	56	39,721
Masons, ...	M.	64	12,804	68	39,741	46	25,875
Painters, . . .	M.	67	14,530	69	35,924	58	30,036
Paper makers:							
Assorters, . .	F.	2	450	2	450	2	400
Undesignated, .	M.	15	3,932	15	7,168	13	5,870
" . .	F.	5	1,123	6	1,202	2	256
Shoemakers:							
Blockers, . .	M.	2	380	2	985	2	975
Boot liners, . .	F.	17	3,016	19	1,890	7	1,091
Boot turners, . .	M.	8	1,765	9	2,885	6	2,163
Bottomers, . .	M.	56	12,679	58	19,999	56	25,265
Burnisher, . .	M.	1	275	1	825	1	600
Crimpers, . .	M.	55	10,925	58	21,960	57	27,635
Cutters, . . .	M.	66	15,318	72	37,502	53	30,057
Dressers, . . .	M.	7	1,450	7	2,597	5	2,875
Edge setters, . .	M.	28	6,142	30	13,167	29	14,747
Finishers, . .	M.	71	15,049	74	30,255	68	29,169
Fitters, . . .	M.	27	5,895	31	13,345	27	12,977
Foremen, . .	M.	5	1,527	6	5,925	5	4,025
Heelers, . . .	M.	50	10,497	54	21,676	47	21,948
" . . .	F.	1	250	1	250	1	250
Lasters, . . .	M.	62	11,840	66	17,801	53	15,649
Levellers, . .	M.	2	275	2	437	2	462
McKay stitcher, .	M.	1	300	1	750	1	500
Packers, . . .	M.	7	1,716	7	4,305	6	4,120
Pasters, . . .	M.	2	350	2	300	1	100
" . . .	F.	6	1,262	6	815	2	300
Peggers, . . .	M.	3	716	3	1,816	3	1,725

NORFOLK COUNTY—Concluded.

OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Shoemakers—*Con.*							
Siders, . . .	M.	1	300	2	$725	2	$1,250
Stitchers, . . .	M.	66	14,635	70	31,123	57	27,659
" . .	F.	10	2,123	10	2,772	9	1,987
Treers, . . .	M.	87	17,463	98	37,610	80	38,504
Trimmers, . .	M.	2	394	2	863	2	775
Undesignated, .	M.	840	179,164	885	324,357	790	353,144
" . .	F.	6	910	7	1,292	4	1,125
Welter, . . .	F.	1	175	1	200	-	-
Straw workers:							
Bleachers, . .	M.	4	858	4	3,319	4	3,087
Blockers, . .	M.	10	1,835	10	5,499	8	4,474
Finisher, . . .	M.	1	125	1	312	1	650
Overseer, . . .	M.	1	150	1	800	1	1,000
Pressers, . . .	M.	11	1,989	12	5,533	11	5,450
Sewers, . . .	F.	154	22,543	174	18,850	69	13,349
Undesignated, .	M.	47	12,691	57	27,930	40	22,568
" .	F.	-	-	1	400	-	-
Tanners, . . .	M.	3	900	3	2,025	2	1,150
Woollen factory operatives:							
Assorters, . .	M.	2	458	3	1,005	2	950
Carders, . . .	M.	7	1,905	7	3,293	6	2,718
Dresser, . . .	M.	1	300	1	1,200	1	900
Finishers, . .	M.	2	608	2	1,422	2	977
Fuller, . . .	M.	1	308	1	500	-	-
Loom fixer, . .	M.	1	225	1	450	1	450
Scourers, . . .	M.	3	780	4	920	4	2,240
Spinner, . . .	M.	1	300	1	600	1	500
" . . .	F.	2	432	2	341	2	560
Undesignated, .	M.	11	2,934	10	4,917	10	4,041
Warper, . . .	M.	1	300	1	600	-	-
Weavers, . .	F.	-	-	2	650	2	120

PLYMOUTH COUNTY.

OCCUPATIONS.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Blacksmiths, . . .	M.	54	13,838	55	$34,238	49	$27,819
Cabinet makers, . .	M.	27	7,026	28	15,597	23	13,479
Carpenters, . . .	M.	283	54,430	290	131,486	223	98,835
Chair maker, . . .	M.	1	200	1	200	1	270
Common laborers, .	M.	423	95,060	434	137,677	321	115,126
Cotton factory operatives:							
Carders, . . .	M.	3	598	3	875	3	1,080
Spinners, . .	M.	3	656	3	918	2	535
" . . .	F.	1	100	1	125	2	324
Undesignated, .	M.	3	640	3	940	2	900
Weavers, . .	M.	6	1,420	6	2,230	6	2,218
Domestic servants, .	F.	179	56,331	221	32,720	85	11,335
Factory operatives:							
Undesignated, .	M.	22	4,523	23	8,208	14	4,975
Weavers, . .	M.	5	1,050	5	1,694	4	1,280
Farm laborers, . .	M.	217	46,470	216	60,552	172	49,891
Machinists, . . .	M.	76	18,231	82	50,479	66	38,859
Masons, ...	M.	103	17,879	106	48,720	86	39,078
Painters, . . .	M.	78	14,529	84	37,905	62	25,380
Shoemakers:							
Bottomers, . .	M.	21	4,266	24	8,571	21	8,875
Burnishers, . .	M.	4	835	4	2,007	2	1,000
Crimpers, . .	M.	17	2,788	17	6,984	14	7,210
Cutters, . . .	M.	229	47,642	231	112,480	184	88,600
Dressers, . .	M.	22	4,108	20	6,476	11	4,468
Edge setters, . .	M.	40	8,267	40	20,801	30	16,912
Eyeleters, . .	F.	5	1,185	5	1,575	3	1,235
Finishers, . .	M.	85	16,794	88	39,444	62	31,803
Fitters, . . .	M.	5	851	5	2,248	5	2,150
Heelers, . . .	M.	43	8,748	43	17,009	27	12,575

PLYMOUTH COUNTY—Continued.

OCCUPATIONS.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Shoemakers—*Con.*							
Lasters, . . .	M.	101	19,960	101	$41,673	56	$21,714
Levellers, . .	M.	3	550	3	725	1	300
Packers, . . .	M.	11	2,474	11	6,132	10	5,589
Pasters, . . .	F.	31	6,021	34	8,324	14	2,746
Peggers, . . .	M.	33	6,570	30	16,282	18	8,261
Stitchers, . .	M.	76	17,082	80	42,252	59	30,103
" . . .	F.	100	19,660	103	30,580	44	11,708
Treer, . . .	M.	18	4,079	18	9,700	11	5,764
Trimmers, . .	M.	17	3,627	21	8,481	14	6,458
Undesignated, .	M.	848	164,312	892	312,024	652	257,222
" . .	F.	39	7,236	43	8,502	4	954
Straw workers:							
Finishers, . .	F.	8	1,275	8	1,155	8	1,010
Shaper, . . .	F.	1	130	1	200	1	175
Trimmer, . .	F.	1	100	1	150	1	100
Undesignated, .	F.	3	542	3	562	3	437
Wirer, . . .	F.	1	100	1	100	1	100
Tanner, ...	M.	1	250	1	300	1	400
Woollen factory operatives:							
Assorters, . .	M.	4	519	4	806	4	1,850
Dresser, . . .	M.	1	250	1	627	1	480
Dyer, . . .	M.	1	236	1	826	1	826
Finishers, . .	M.	2	370	2	860	2	1,000
Fuller, . . .	M.	1	274	1	411	1	600
Specker, . . .	F.	1	130	1	130	1	225
Spinners, . .	M.	13	2,608	14	3,888	12	3,879
Spooler, . . .	M.	1	230	1	400	1	400
Undesignated, .	M.	1	300	1	450	1	300
" . .	F.	1	64	1	85	–	-
Weavers, . .	F.	9	2,380	9	3,450	9	2,405

SUFFOLK COUNTY.

OCCUPATIONS.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Blacksmiths, . . .	M.	89	21,854	93	$53,278	68	$37,035
Cabinet makers, . .	M.	46	11,561	46	28,510	33	20,291
Carpenters, . . .	M.	408	91,118	411	236,096	287	167,558
Chair makers:							
Finisher, . . .	M.	1	350	1	860	1	860
Ornamenter, . .	M.	1	300	1	600	1	360
" . . .	F.	1	260	1	325	1	243
Undesignated, .	M.	6	1,603	6	3,498	4	2,550
Common laborers, .	M.	1,126	251,853	1,128	465,331	769	331,553
Curriers:							
Morocco dressers, .	M.	2	600	2	1,200	1	500
Undesignated, .	M.	38	8,854	35	19,259	24	12,106
Domestic servants, .	F.	1,653	546,343	1,804	311,301	730	100,538
Farm laborers, . .	M.	26	6,520	27	9,853	16	5,492
Jewellery makers, . .	M.	2	400	2	767	2	667
" " . .	F.	-	-	1	104	1	156
Machinists, . . .	M.	188	47,060	184	132,455	135	86,409
Masons, ...	M.	101	21,523	106	69,492	81	43,801
Painters, . . .	M.	118	25,677	123	63,201	81	41,352
Shoemakers:							
Fitter, . . .	M.	1	283	1	800	1	600
Stitcher, . . .	F.	1	275	1	307	1	500
Undesignated, .	M.	72	18,051	71	38,296	54	26,993
" . . .	F.	2	624	2	468	-	-
Straw workers:							
Presser, . . .	M.	1	200	1	600	-	-
Sewer, . . .	F.	1	311	1	416	-	-
Undesignated, .	F.	2	140	2	340	1	150

WORCESTER COUNTY.

OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Armorers,	M.	25	6,621	27	$16,907	23	$12,337
Blacksmiths,	M.	120	31,676	115	72,641	106	62,437
Cabinet makers,	M.	71	16,147	72	35,857	57	25,728
Carpenters,	M.	634	140,251	632	347,333	546	279,316
Chair makers:							
Cane seaters,	M.	7	1,135	7	359	-	-
" "	F.	14	2,778	16	1,553	9	1,059
Finishers,	M.	4	1,013	4	1,612	2	750
Sawyers,	M.	1	200	1	673	2	880
Stock turners,	M.	6	1,110	6	2,250	5	1,575
Undesignated,	M.	373	88,747	385	173,770	333	155,734
Common laborers,	M.	661	151,693	665	243,575	544	216,585
Cotton factory operatives:							
Beamer,	M.	1	200	1	300	1	450
Carders,	M.	14	3,882	16	7,270	13	5,890
Card grinders,	M.	1	275	2	779	2	638
Card strippers,	M.	2	450	2	486	1	500
Dressers,	M.	7	1,815	8	3,285	5	2,470
Finisher,	M.	1	300	1	450	1	450
Lapper tenders,	M.	3	656	3	945	1	400
Loom fixers,	M.	7	1,656	7	2,462	3	1,264
Picker tenders,	M.	-	-	2	800	2	1,150
Speeder tenders,	F.	3	900	3	750	2	344
Spinners,	M.	16	3,628	18	6,508	13	4,678
"	F.	6	2,516	8	1,646	4	706
Spoolers,	M.	3	905	2	1,060	2	740
"	F.	-	-	3	610	3	610
Undesignated,	M.	16	4,019	21	6,588	16	6,324
"	F.	4	1,106	4	1,008	2	450

WORCESTER COUNTY—CONTINUED.

OCCUPATIONS.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Cotton factory operatives—*Con.*							
Warper, . . .	F.	1	200	1	$166	-	-
Weavers, . . .	M.	37	9,943	37	15,145	25	$10,603
" . . .	F.	27	6,582	36	8,456	29	6,070
Web drawer, . .	F.	1	299	1	373	1	225
Curriers:							
Finisher, . . .	M.	1	225	1	337	1	337
Undesignated, .	M.	44	11,206	46	25,955	29	16,054
Cutler:							
Finisher, . . .	M.	1	300	1	375	1	375
Domestic servants, .	F.	808	251,256	846	123,250	383	45,985
Factory operatives:							
Burlers, . . .	F.	11	2,698	11	1,912	5	1,150
Carders, . . .	M.	37	9,174	34	13,983	31	11,902
" . . .	F.	3	750	3	656	1	246
Card grinders, .	M.	2	470	2	570	1	600
Card strippers, .	M.	3	750	3	992	1	300
Cloth trimmers, .	F.	3	789	2	383	-	-
Drawer in, . .	M.	1	200	1	200	1	300
" . .	F.	5	1,173	5	1,351	3	885
Dressers, . . .	M.	18	4,622	16	8,488	13	7,957
Dyers, . . .	M.	1	214	1	937	2	600
Finishers, . .	M.	11	2,753	12	4,788	11	5,094
" . .	F.	2	548	2	395	-	-
Giggers, . . .	F.	4	900	4	480	-	-
Lapper tender, .	M	1	200	1	212	1	525
Loom fixers, . .	M.	7	2,105	8	4,566	7	4,110
Picker tenders, .	M.	4	1,020	4	1,490	3	*1,250
Slasher tender, .	M.	1	300	1	675	1	600
Speeder tenders, .	F.	9	2,118	9	2,343	2	304

WORCESTER COUNTY—CONTINUED.

OCCUPATIONS.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Fact'y operatives—*Con.*							
Spinners, . . .	M.	51	13,082	53	$19,781	46	$17,623
" . . .	F.	21	5,079	19	2,931	16	2,335
Spoolers, . . .	F.	14	3,365	15	2,124	8	1,495
Undesignated, .	M.	149	36,153	147	50,365	110	51,747
" . .	F.	38	9,032	40	9,252	15	2,912
Warpers, . .	F.	6	1,432	6	1,307	3	625
Weavers, . .	M.	84	20,494	87	27,564	72	24,521
" . .	F.	158	37,223	162	36,650	81	18,945
Farm laborers, . .	M.	722	166,770	758	219,708	494	170,530
Machinists, . . .	M.	603	151,869	601	366,451	516	306,007
Masons, ...	M.	122	21,897	132	66,110	116	60,280
Painters, ...	M.	212	43,939	212	95,989	186	86,837
Paper makers, . .	M.	31	9,148	30	21,201	23	13,761
" " . .	F.	3	1,160	4	935	2	515
Shoemakers:							
Boot turners, . .	M.	5	1,164	5	2,318	5	2,876
Bottomers, . .	M.	313	69,347	326	125,704	290	119,699
Buffer, . . .	M.	1	225	1	450	1	450
Counter makers, .	M.	3	587	3	1,235	2	790
Crimpers, . .	M.	76	17,569	76	36,582	66	32,275
Cutters, . . .	M.	314	75,267	321	187,713	277	156,286
" . . .	F.	3	712	3	533	-	-
Dressers, . . .	M.	9	2,400	9	3,308	7	2,458
" . . .	F.	2	416	2	416	2	416
Edge setters, . .	M.	6	1,203	5	1,906	4	2,143
Finishers, . .	M.	88	20,970	92	47,763	75	38,210
Fitters, . . .	M.	31	7,120	31	16,252	25	13,082
" . . .	F.	3	830	3	972	2	288
Heelers, . . .	M.	45	9,917	52	21,755	40	17,627
Inspectors, . .	M.	5	1,280	5	2,910	5	2,600

WORCESTER COUNTY—CONTINUED.

OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Shoemakers—*Con.*							
Lasters, . . .	M.	75	15,417	92	$31,748	73	$25,908
Machine Peggers, .	M.	3	850	3	2,212	2	1,400
Nailers, . . .	M.	4	725	4	1,048	4	1,450
Packers, . . .	M.	11	2,571	11	5,546	10	5,260
Pasters, . . .	F.	17	3,251	17	2,742	8	1,551
Peggers, . . .	M.	24	5,379	24	12,601	20	10,238
Siders, . . .	M.	40	9,617	43	23,350	33	17,825
Skivers, . . .	M.	5	1,191	5	2,379	5	2,000
Stitchers, . . .	M.	19	4,020	20	8,217	14	6,349
" . . .	F.	87	20,137	93	24,303	64	14,491
Treers, . . .	M.	181	43,858	187	100,531	167	87,633
Trimmers, . .	M.	48	10,405	61	28,175	53	25,747
Undesignated, .	M.	688	156,234	781	324,870	617	274,221
" . .	F.	33	7,238	33	6,957	21	5,037
Straw workers:							
Blockers, . . .	M.	15	2,803	15	6,930	15	6,943
Finishers, . .	M.	5	993	5	2,335	3	1,345
" . . .	F.	8	1,279	8	1,693	2	650
Machine sewers, .	F.	5	801	5	1,184	1	108
Pressers, . . .	M.	12	2,260	12	5,168	9	4,125
Sewers, . . .	F.	43	6,345	45	5,318	13	2,422
Shaper, . . .	F.	1	200	1	200	1	250
Trimmers, . .	F.	3	475	3	632	2	312
Undesignated, .	M.	35	7,932	33	15,215	26	15,004
" . .	F.	64	10,872	65	14,497	38	9,451
Wirers, . . .	F.	17	2,477	17	2,720	5	1,070
Tanners, . . .	M.	3	813	3	2,450	2	954
Woollen factory operatives:							
Assorters, . .	M.	35	8,748	40	19,041	35	17,578
Carders, . . .	M.	42	10,045	40	14,685	36	13,661

WORCESTER COUNTY—CONCLUDED.

OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Woollen factory operatives—*Con.*							
Dressers, . . .	M.	2	525	2	$600	-	-
Dyers, . . .	M.	34	8,706	33	15,086	31	$12,061
Fullers, . . .	M.	7	1,673	7	1,794	7	2,065
Giggers, . . .	M.	11	2,669	10	2,564	9	4,280
Loom fixers, . .	M.	28	6,911	28	12,161	25	10,467
Oilers, . . .	M.	2	523	2	838	1	450
Picker tenders, .	M.	11	2,715	11	2,700	9	4,000
Pressers, . . .	M.	15	3,715	15	3,681	15	4,564
Reelers, . . .	F.	5	900	5	410	-	-
Scourers, . . .	M.	7	1,751	7	2,092	6	1,615
Shearers, . . .	M.	2	575	1	300	1	200
Spinners, . . .	M.	36	8,266	39	14,367	30	12,804
" . . .	F.	2	470	2	296	2	226
Undesignated, .	M.	5	1,420	6	4,569	4	1,904
" . .	F.	15	3,199	15	3,076	7	1,140
Warper, . . .	M.	1	112	1	154	-	-
Weavers, . . .	M.	37	8,200	41	12,534	26	9,644
" . . .	F.	12	2,688	9	1,580	4	705

Presentation by Occupations.

The preceding pages of this chapter exhibited the facts respecting the three points considered, by counties; the following pages show them by occupations. The number of persons answering each question is shown, and the aggregates in respect to each question. Succeeding this presentation will be found tables of averages, deduced from the aggregates here given. The averages alone might mislead the reader. We therefore present this table of aggregates, that the basis of computation may be always in his hands :—

ARMORERS.

Counties and Subdivisions of Occupations.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Hampden, . . .	M.	221	58,954	227	$164,778	231	$161,339
Hampshire, . . .	"	17	4,432	16	7,555	12	5,759
Worcester, . . .	"	25	6,621	27	16,907	23	12,337
Totals, . . .	.	263	70,007	270	$189,240	266	$179,435

BLACKSMITHS.

Counties and Subdivisions of Occupations.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Barnstable, . . .	M.	7	2,043	7	$4,859	6	$3,190
Berkshire, . . .	"	25	6,610	27	13,225	23	9,765
Bristol, ...	"	43	10,765	43	23,175	35	17,957
Dukes, ...	"	4	950	4	1,824	4	1,875
Essex, ...	"	68	17,675	69	39,163	51	27,379
Franklin, . . .	"	23	5,402	23	12,654	17	8,884
Hampden, . . .	"	72	19,417	71	34,818	58	26,329
Hampshire, . . .	"	5	1,213	5	3,250	5	2,250
Middlesex, . . .	"	114	29,740	117	70,772	100	55,369
Norfolk, ...	"	48	11,328	48	24,874	39	21,820
Plymouth, . . .	"	54	13,838	55	34,238	49	27,819
Suffolk, ...	"	89	21,854	93	53,278	68	37,035
Worcester, . . .	"	120	31,676	115	72,641	106	62,437
Totals, . . .	.	672	172,511	677	$388,771	561	$302,109

CABINET MAKERS.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Berkshire, ...	M.	7	1,895	7	$3,539	6	$3,150
Bristol, ...	"	1	200	2	960	1	1,060
Essex, ...	"	46	10,523	48	23,064	37	19,209
Franklin, . . .	"	15	3,537	16	6,299	12	4,297
Hampden, . . .	"	5	1,396	6	4,616	5	3,258
Hampshire, . . .	"	1	205	1	615	1	639
Middlesex, . . .	"	74	18,499	77	45,162	60	34,023
Norfolk, ...	"	17	4,076	17	10,201	13	8,355
Plymouth, . . .	"	27	7,026	28	15,597	23	13,479
Suffolk, ...	"	46	11,561	46	28,510	33	20,291
Worcester, . . .	"	71	16,147	72	35,857	67	25,723
Totals, . . .	.	310	75,065	320	$174,420	248	$133,489

CARPENTERS.

Barnstable, . . .	M.	132	23,780	134	$61,998	121	$54,126
Berkshire, . . .	"	131	29,305	150	77,984	126	64,826
Bristol, ...	"	173	36,460	181	97,306	155	83,318
Dukes, ...	"	47	6,813	50	20,228	48	20,710
Essex, ...	"	399	87,237	409	218,566	346	186,912
Franklin, . . .	"	93	19,970	97	49,152	84	38,456
Hampden, . . .	"	396	94,150	402	227,779	315	178,160
Hampshire, . . .	"	62	13,647	65	32,322	44	20,915
Middlesex, . . .	"	886	199,401	894	502,378	724	394,778
Norfolk, ...	"	256	55,787	266	144,717	213	114,538
Plymouth, . . .	"	283	54,430	290	131,486	223	96,835
Suffolk, ...	"	408	91,118	411	236,096	287	167,558
Worcester, . . .	"	634	140,251	632	347,333	546	279,316
Totals, . . .	.	3,900	852,349	3,981	$2,147,345	3,232	$1,702,498

CHAIR MAKERS.

Counties and subdivisions of occupations.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Cane Seaters.							
Worcester, . . .	M.	7	1,135	7	$359	-	-
Worcester, . . .	F.	14	2,778	16	1,553	9	$1,059
Finishers.							
Suffolk, ...	M.	1	350	1	860	1	860
Worcester, . . .	"	4	1,013	4	1,612	2	750
Totals, . . .	.	5	1,363	5	$2,472	3	$1,610
Ornamenters.							
Suffolk, ...	M.	1	300	1	$600	1	$360
Suffolk, ...	F.	1	260	1	325	1	243
Sawyers.							
Worcester, . . .	M.	1	200	1	673	2	850
Stock Turners.							
Worcester, . . .	M.	6	1,110	6	2,250	5	1,575
Undesignated.							
Berkshire, . . .	M.	1	200	1	300	1	250
Essex, ...	"	6	1,355	6	1,907	5	1,665
Franklin, . . .	"	15	3,943	14	6,550	11	4,254
Middlesex, . . .	"	27	6,432	27	12,132	21	9,243
Norfolk, . . .	"	1	200	1	250	-	-
Plymouth, . . .	"	1	200	1	200	1	270
Suffolk, ...	"	6	1,603	6	3,498	4	2,550
Worcester, . . .	"	373	88,747	385	173,770	333	155,734
Totals, . . .	.	430	102,680	441	$198,607	376	$173,966

COMMON LABORERS.

Barnstable, . . .	M.	87	19,223	93	$31,163	86	$28,577
Berkshire, . . .	"	257	58,433	266	91,688	210	78,884
Bristol, ...	"	304	66,618	309	112,133	260	122,408
Dukes, ...	"	36	6,364	42	12,200	36	12,262

COMMON LABORERS—CONTINUED.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Essex, ...	M.	412	95,003	421	$151,006	312	$131,523
Franklin, . . .	"	71	16,058	74	25,303	49	19,736
Hampden, . . .	"	249	60,295	257	98,583	196	98,430
Hampshire, . . .	"	65	13,012	63	19,748	44	16,676
Middlesex, . . .	"	1,260	284,871	1,285	482,719	1,080	457,992
Nantucket, . . .	"	6	1,420	6	1,850	1	365
Norfolk, . . .	"	459	99,242	479	154,498	356	148,474
Plymouth, . . .	"	423	95,060	434	137,677	321	115,126
Suffolk, ...	"	1,126	251,853	1,128	465,331	769	331,553
Worcester, . . .	"	661	151,693	665	243,575	544	216,585
Totals, . . .	.	5,416	1,219,145	5,622	$2,027,474	4,264	$1,778,596

COTTON FACTORY OPERATIVES.

Assorters.							
Middlesex, . . .	M.	1	300	1	$600	-	-
Beamers.							
Berkshire, . . .	M.	1	250	1	500	1	$500
Worcester, . . .	"	1	200	1	300	1	450
Totals, . . .	.	2	450	2	$800	2	$950
Carders.							
Berkshire, . . .	M.	13	3,050	12	$3,100	7	$2,600
Bristol, ...	"	31	7,349	33	9,516	21	10,218
Essex, ...	"	18	4,286	19	6,453	14	5,959
Franklin, . . .	"	1	300	1	249	1	156
Hampden, . . .	"	32	8,491	32	16,580	21	11,826
Middlesex, . . .	"	79	21,304	79	37,718	67	30,579
Norfolk, . . .	"	2	463	2	832	1	300
Plymouth, . . .	"	3	598	3	875	3	1,080
Worcester, . . .	"	14	3,882	16	7,270	13	5,890
Totals, . . .	.	193	49,723	197	$82,593	148	$68,608

COTTON FACTORY OPERATIVES—CONTINUED.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	SEX.	DAYS EMPLOYED.		YEARLY WAGES.		COST OF LIVING.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Carders—*Con.*							
Berkshire, . . .	F.	2	580	2	$820	1	$550
Bristol, ...	"	8	1,906	8	1,590	2	508
Essex, ...	"	14	3,421	12	3,051	7	1,249
Hampden, . . .	"	33	8,349	32	7,368	7	1,199
Hampshire, . . .	"	5	1,050	6	1,174	2	437
Middlesex, . . .	"	74	18,914	67	15,198	58	10,095
Totals, . . .	.	136	34,220	127	$29,201	77	$14,038
Card Grinders.							
Berkshire, . . .	M.	1	300	1	$450	1	$400
Bristol, ...	"	5	1,275	5	1,822	5	2,030
Hampden, . . .	"	3	870	3	1,155	2	865
Middlesex, . . .	"	5	1,350	5	2,168	4	1,275
Norfolk, . . .	"	1	300	1	500	-	-
Worcester, . . .	"	1	275	2	779	2	638
Totals, . . .	.	16	4,370	17	$6,874	14	$5,208
Card Strippers.							
Bristol, ...	M.	2	525	3	$962	3	$1,270
Essex, ...	"	2	400	2	450	2	682
Hampden, . . .	"	2	580	2	571	-	-
Middlesex, . . .	"	5	1,197	4	1,245	4	1,244
Worcester, . . .	"	2	450	2	486	1	500
Totals, . . .	.	13	3,152	13	$3,734	10	$3,696
Middlesex, . . .	F.	1	300	1	$300	1	$300
Cloth Trimmers.							
Bristol, ...	F.	-	-	-	-	1	$450
Hampden, . . .	"	2	350	2	$320	1	150
Totals, . . .	.	2	350	2	$320	2	$600
Drawers In.							
Bristol, ...	M.	2	450	2	$565	2	$644
Bristol, ...	F.	3	590	3	520	1	95

COTTON FACTORY OPERATIVES—Continued.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Dressers.							
Berkshire, . . .	M.	3	862	3	$1,777	3	$1,750
Franklin, . . .	"	2	510	2	1,225	2	880
Hampden, . . .	"	14	3,747	15	7,984	12	6,638
Middlesex, . . .	"	3	700	3	1,010	2	600
Norfolk, ...	"	2	550	2	1,000	2	1,300
Worcester, . . .	"	7	1,815	8	3,285	5	2,470
Totals, . . .	.	31	8,184	33	$16,281	26	$13,638
Essex, ...	F.	2	553	2	$1,043	2	$1,137
Middlesex, . . .	"	5	1,300	5	1,300	-	-
Totals, . . .	.	7	1,853	7	$2,343	2	$1,127
Dyers.							
Hampden, . . .	M.	1	313	1	$500	1	$500
Middlesex, . . .	"	6	1,445	6	3,235	5	2,379
Totals, . . .	.	7	1,758	7	$3,735	6	$2,879
Finishers.							
Essex, ...	M.	7	1,839	7	$2,468	5	$1,940
Hampden, . . .	"	2	544	2	1,779	2	1,700
Hampshire, . . .	"	3	913	3	1,680	-	-
Middlesex, . . .	"	3	485	3	785	3	1,160
Worcester, . . .	"	1	300	1	450	1	450
Totals, . . .	.	16	4,081	16	$7,162	11	$5,250
Middlesex, . . .	F.	2	350	2	$313	2	$277
Folders.							
Hampden, . . .	M.	1	300	1	$675	-	-
Hampden, . . .	F.	3	625	3	$562	2	$275
Middlesex, . . .	"	3	854	3	875	2	395
Totals, . . .	.	6	1,479	6	$1,437	4	$670
Inspectors.							
Hampden, . . .	F.	2	560	2	$435	2	$350

COTTON FACTORY OPERATIVES—CONTINUED.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Lapper Tenders.							
Worcester, . . .	M.	3	656	3	$945	1	$400
Loom Fixers.							
Bristol, ...	M.	6	1,400	6	$2,809	6	$4,187
Hampden, . . .	"	5	1,196	5	1,817	5	1,815
Middlesex, . . .	"	4	944	4	1,679	4	2,025
Worcester, . . .	"	7	1,656	7	2,462	3	1,264
Totals, . . .	.	22	5,196	22	$8,767	18	$9,291
Mule Spinners.							
Middlesex, . . .	M.	3	875	3	$1,722	3	$1,200
Norfolk, . . .	"	1	312	1	499	1	540
Totals, . . .	.	4	1,187	4	$2,221	4	$1,740
Oilers.							
Middlesex, . . .	M.	10	1,009	4	$1,339	3	$1,540
Overseers.							
Bristol, ...	M.	3	880	3	$2,123	2	$1,050
Franklin, . . .	"	2	585	2	1,462	2	1,200
Norfolk, ...	"	2	498	2	1,294	1	750
Totals, . . .	.	7	1,963	7	$4,879	5	$3,000
Packers.							
Middlesex, . . .	F.	1	200	1	$144	-	-
Picker Tenders.							
Bristol, ...	M.	7	1,673	7	$1,950	1	$750
Essex, ...	"	7	1,590	7	1,647	6	3,060
Hampden, . . .	"	4	1,160	4	1,170	3	975
Middlesex, . . .	"	11	2,853	11	4,480	8	3,996
Worcester, . . .	"	-	-	2	800	2	1,150
Totals, . . .	.	29	7,276	31	$10,047	20	$9,931
Essex, ...	F.	41	9,216	39	$9,091	31	$6,163
Hampden, . . .	"	3	740	3	630	2	410
Totals, . . .	.	44	9,956	42	$9,721	33	$6,573

COTTON FACTORY OPERATIVES—Continued.

Counties and Subdivisions of Occupations.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Quillers.							
Berkshire, . . .	F.	1	234	1	$156	1	$140
Second Hands.							
Bristol, ...	M.	1	250	1	$500	1	$400
Section Hands.							
Hampden, . . .	M.	1	225	1	$450	1	$500
Slasher Tenders.							
Bristol, ...	M.	8	1,830	7	$3,117	4	$434
Essex, ...	"	1	300	1	500	1	300
Middlesex, . . .	"	6	1,806	6	3,284	5	2,351
Totals, . . .	.	15	3,936	14	$6,901	10	$3,085
Speeder Tenders.							
Franklin, . . .	M.	1	286	1	$430	1	$600
Bristol, ...	F.	25	5,570	25	$6,289	4	$1,065
Franklin, . . .	"	3	675	3	588	2	426
Middlesex, . . .	"	1	270	1	297	1	297
Norfolk, . . .	"	3	790	2	497	-	-
Worcester, . . .	"	3	900	3	750	2	344
Totals, . . .	.	35	8,205	34	$8,421	9	$2,132
Spinners.							
Berkshire, . . .	M.	11	2,708	10	$3,945	5	$3,100
Bristol, ...	"	58	13,723	58	23,708	48	22,416
Essex, ...	"	14	3,928	14	7,334	14	6,824
Franklin, . . .	"	4	1,055	4	1,666	3	1,400
Hampden, . . .	"	40	10,698	40	21,270	33	16,351
Middlesex, . . .	"	79	21,120	76	38,345	64	30,087
Norfolk, . . .	"	6	1,553	5	1,449	3	1,128
Plymouth, . . .	"	3	656	3	918	2	535
Worcester, . . .	"	16	3,628	18	6,508	13	4,678
Totals, . . .	.	231	59,069	228	$105,143	185	$86,519

COTTON FACTORY OPERATIVES—Continued.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Spinners—*Con.*							
Berkshire, . . .	F.	18	4,345	18	$3,495	7	$1,055
Bristol, ...	"	20	4,978	23	4,878	1	300
Essex, ...	"	6	1,809	6	1,632	4	795
Hampden, . . .	"	28	6,231	27	8,324	25	4,539
Middlesex, . . .	"	130	32,642	127	26,131	102	17,916
Norfolk, . . .	"	2	600	2	394	1	250
Plymouth, . . .	"	1	100	1	125	2	324
Worcester, . . .	"	6	2,516	8	1,646	4	706
Totals, . . .	.	211	53,221	212	$46,625	146	$25,885
Spoolers.							
Bristol, ...	M.	9	2,000	9	$3,295	4	$1,595
Hampden, . . .	"	5	2,281	5	2,406	5	3,294
Middlesex, . . .	"	1	313	1	406	1	450
Worcester, . . .	"	3	905	2	1,060	2	740
Totals, . . .	.	18	5,499	17	$7,167	12	$6,079
Berkshire, . . .	F.	15	3,465	15	$2,538	5	$715
Bristol, ...	"	19	4,301	18	2,950	4	1,042
Franklin, . . .	"	1	275	1	247	-	-
Hampden, . . .	"	9	2,456	9	2,309	8	1,275
Middlesex, . . .	"	82	19,459	85	16,593	47	8,094
Norfolk, . . .	"	1	175	1	105	-	-
Worcester, . . .	"	-	-	3	610	3	610
Totals, . . .	.	127	30,131	132	$25,352	67	$11,736
Undesignated.							
Berkshire, . . .	M.	13	3,585	18	$11,484	17	$10,070
Bristol, ...	"	6	1,375	7	2,229	6	1,835
Essex, ...	"	15	4,210	14	6,242	11	4,585
Hampden, . . .	"	7	2,040	8	3,878	3	1,475
Middlesex, . . .	"	9	2,335	10	4,007	6	2,550
Norfolk, . . .	"	5	1,192	5	1,669	5	2,275

COTTON FACTORY OPERATIVES—Continued.

Counties and Subdivisions of Occupations.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Undesignated—*Con.*							
Plymouth,	M.	3	640	3	$940	2	$900
Worcester,	"	16	4,019	21	6,588	16	6,324
Totals,	.	74	19,396	86	$37,037	66	$30,014
Bristol,	F.	1	150	1	$120	-	-
Middlesex,	"	7	1,326	7	1,132	4	$695
Worcester,	"	4	1,106	4	1,008	2	450
Totals,	.	12	2,582	12	$2,260	6	$1,145
Warpers.							
Berkshire,	F.	2	500	2	$560	-	-
Bristol,	"	1	260	1	234	-	-
Middlesex,	"	20	5,470	21	5,000	15	$2,615
Norfolk,	"	4	800	4	804	2	564
Worcester,	"	1	200	1	166	-	-
Totals,	.	28	7,230	29	$6,764	17	$3,179
Weavers.							
Berkshire,	M.	14	3,164	15	$4,702	7	$4,850
Bristol,	"	156	35,215	157	53,945	90	34,502
Essex,	"	36	7,895	33	9,767	21	8,260
Franklin,	"	4	1,090	4	1,284	2	382
Hampden,	"	5	1,292	5	2,214	4	1,900
Middlesex,	"	75	20,155	72	33,533	59	24,350
Norfolk,	"	7	1,020	5	817	1	150
Plymouth,	"	6	1,420	6	2,230	6	2,218
Worcester,	"	37	9,943	37	15,145	25	10,603
Totals,	.	340	81,194	334	$123,637	215	$87,215
Berkshire,	F.	51	12,626	51	$12,192	23	$4,670
Bristol,	"	110	24,002	112	30,413	43	11,753
Franklin,	"	17	3,734	17	3,938	8	1,348
Hampden,	"	188	44,745	188	53,186	154	39,775

COTTON FACTORY OPERATIVES—CONCLUDED

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.
Weavers—Con.					
Hampshire, ...	F.	2	560	4	$1,045
Middlesex, ...	"	602	146,228	601	142,464
Norfolk, ...	"	3	750	3	975
Worcester, ...	"	27	6,582	36	8,456
Totals, ...	.	1,000	239,227	1,012	$252,669
Web Drawers.					
Middlesex, ...	F.	30	7,126	29	$6,325
Worcester, ...	"	1	299	1	373
Totals, ...	.	31	7,425	30	$6,698
Winders.					
Bristol, ...	M.	-	-	-	-
Middlesex, ...	F.	2	588	1	$293

CURRIERS.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.
Beamsters.					
Middlesex, ...	M.	-	-	2	$520
Buffers.					
Middlesex, ...	M.	1	310	1	$620
Finishers.					
Essex, ...	M.	18	4,704	21	$9,940
Middlesex, ...	"	19	4,496	19	8,910
Worcester, ...	"	1	225	1	337
Totals, ...	.	38	9,425	41	$19,187
Measurers.					
Middlesex, ...	M.	2	599	3	$2,376
Morocco Dressers.					
Essex, ...	M.	35	9,166	37	$21,929
Suffolk, ...	"	2	600	2	1,200
Totals, ...	.	37	9,766	39	$23,129

CURRIERS—CONTINUED.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Scourers.							
Middlesex, . . .	M.	1	325	1	$487	1	$500
Splitters.							
Middlesex, . . .	M.	6	1,622	6	$5,923	6	$3,680
Stuffers.							
Middlesex, . . .	M.	7	1,648	7	$3,158	6	$2,725
Tablemen.							
Middlesex, . . .	M.	10	2,211	9	$3,922	8	$2,950
Undesignated.							
Barnstable, . . .	M.	5	1,071	5	$1,917	5	$1,710
Berkshire, . . .	"	23	6,112	18	9,775	18	8,902
Bristol, ...	"	3	690	3	2,165	3	1,000
Essex, ...	"	84	20,437	92	40,718	47	21,022
Hampden, . . .	"	1	313	1	420	1	420
Middlesex, . . .	"	437	107,659	446	206,421	417	195,082
Norfolk, ...	"	17	3,762	16	8,374	10	5,447
Suffolk, ...	"	38	8,854	35	19,259	24	12,106
Worcester, . . .	"	44	11,206	46	25,955	29	16,054
Totals, . . .	.	652	160,104	662	$315,004	554	$261,743

CUTLERS.

Blade Oilers.							
Franklin, . . .	M.	1	260	1	$260	1	$260
Bolster Droppers.							
Franklin, . . .	M.	1	250	1	$500	1	$500
Finishers.							
Franklin, . . .	M.	17	3,646	17	$5,897	17	$6,985
Worcester, . . .	"	1	300	1	375	1	375
Totals, . . .	.	18	3,946	18	$6,272	18	$7,360
Forgers.							
Franklin, . . .	M.	3	590	4	$1,725	4	$1,740

CUTLERS—CONTINUED.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	SEX.	DAYS EMPLOYED. Number answering.	DAYS EMPLOYED. Aggregate.	YEARLY WAGES. Number answering.	YEARLY WAGES. Aggregate.
Grinders.					
Franklin, . . .	M.	35	7,301	35	$13,246
Hafters.					
Franklin, . . .	M.	2	394	2	$716
Handle Riveters.					
Franklin, . . .	M.	1	150	1	$300
Handle Sawyers.					
Franklin, . . .	M.	2	520	2	$1,177
Knife Cleaners.					
Franklin, . . .	F.	2	460	2	$460
Polishers.					
Franklin, . . .	M.	1	225	1	$394
Temperers.					
Franklin, . . .	M.	1	208	1	$512
Undesignated.					
Bristol, ...	M.	4	754	4	$1,183
Franklin, . . .	"	120	28,390	126	55,694
Hampshire, . . .	"	21	5,031	20	11,300
Totals, . . .	.	145	34,175	150	$68,177

DOMESTIC SERVANTS.

Barnstable, . . .	F.	64	14,954	65	$6,592
Berkshire, . . .	"	178	54,417	193	25,616
Bristol, ...	"	322	107,384	383	62,132
Dukes, ...	"	2	565	2	482
Essex, ...	"	499	161,387	545	90,342
Franklin, . . .	"	128	35,981	142	19,387
Hampden, . . .	"	300	94,088	308	48,661
Hampshire, . . .	"	116	34,494	119	17,265
Middlesex, . . .	"	1,551	494,464	1,648	277,122

DOMESTIC SERVANTS—Continued.

Counties and Subdivisions of Occupations.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Nantucket, . . .	F.	8	2,710	8	$864	2	$155
Norfolk, . . .	"	212	68,066	249	37,292	96	13,939
Plymouth, . . .	"	179	56,331	221	32,720	85	11,335
Suffolk, ...	"	1,653	546,343	1,804	311,301	730	100,538
Worcester, . . .	"	808	251,256	846	123,250	383	45,985
Totals, . . .	.	6,020	1,922,440	6,533	$1,053,026	3,008	$399,849

FACTORY OPERATIVES.

Counties and Subdivisions of Occupations.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Beamers.							
Berkshire, . . .	M.	-	-	-	-	1	$500
Burlers.							
Worcester, . . .	F.	11	2,698	11	$1,912	5	$1,150
Carders.							
Berkshire, . . .	M.	4	1,140	5	$2,277	3	$1,500
Bristol, ...	"	11	2,625	11	4,113	10	4,346
Essex, ...	"	5	1,407	5	3,550	4	2,837
Hampden, . . .	"	14	3,885	14	4,633	5	2,800
Middlesex, . . .	"	4	1,100	3	1,275	3	1,245
Norfolk, . . .	"	9	2,534	10	3,927	7	2,722
Worcester, . . .	"	37	9,174	34	13,983	31	11,902
Totals, . . .	.	84	21,865	82	$33,758	63	$27,352
Bristol, ...	F.	5	1,010	6	$1,358	3	$632
Essex, ...	"	4	1,080	4	957	5	1,489
Hampden, . . .	"	30	7,270	30	5,439	9	1,500
Worcester, . . .	"	3	750	3	656	1	246
Totals, . . .	.	42	10,110	43	$8,410	18	$3,867
Card Grinders.							
Bristol, ...	M.	6	1,590	6	$2,337	3	$1,550
Hampden, . . .	"	-	-	1	438	1	438

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	SEX.	DAYS EMPLOYED. Number answering.	DAYS EMPLOYED. Aggregate.	YEARLY WAGES. Number answering.	YEARLY WAGES. Aggregate.	COST OF LIVING. Number answering.	COST OF LIVING. Aggregate.
Card Grinders—*Con.*							
Middlesex, . . .	M.	6	1,519	6	$2,258	5	$2,305
Worcester, . . .	"	2	470	2	570	1	600
Totals, . . .	.	14	3,579	15	$5,603	10	$4,893
Card Inspectors.							
Norfolk, . . .	F.	-	-	1	$300	1	$300
Card Strippers.							
Bristol, ...	M.	1	150	1	$187	-	-
Middlesex, . . .	"	4	984	4	1,224	4	$1,532
Worcester, . . .	"	3	750	3	992	1	300
Totals, . . .	.	8	1,884	8	$2,403	5	$1,832
Cloth Trimmers.							
Bristol, ...	F.	10	2,209	12	$2,813	8	$2,142
Worcester, . . .	"	3	789	2	383	-	-
Totals, . . .	.	13	2,998	14	$3,196	8	$2,142
Doffers.							
Bristol, ...	M.	1	110	1	$110	-	-
Drawers In.							
Bristol, ...	M.	1	313	1	$400	1	$390
Worcester, . . .	"	1	200	1	200	1	300
Totals, . . .	.	2	513	2	$600	2	$690
Bristol, ...	F.	32	7,243	32	$7,440	16	$3,161
Essex, ...	"	17	4,212	14	2,874	8	1,754
Worcester, . . .	"	5	1,173	5	1,351	3	885
Totals, . . .	.	54	12,628	51	$11,665	27	$5,800
Dressers.							
Berkshire, . . .	M.	1	240	1	$450	1	$300
Essex, ...	"	9	2,232	6	2,276	5	2,453
Hampden, . . .	"	3	800	3	710	-	-
Norfolk, . . .	"	2	542	2	915	1	725
Worcester, . . .	"	18	4,622	16	8,488	13	7,957
Totals, . . .	.	33	8,436	28	$12,839	20	$11,435

FACTORY OPERATIVES—Continued.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Dyers.							
Bristol, ...	M.	1	150	1	$114	1	$100
Hampden, . . .	"	1	290	1	725	1	600
Norfolk, ...	"	2	347	2	1,000	1	400
Worcester, . . .	"	1	214	1	937	2	600
Totals, . . .	.	5	1,001	5	$2,776	5	$1,700
Finishers.							
Berkshire, . . .	M.	3	768	3	$2,056	3	$1,340
Hampden, . . .	"	1	40	1	40	-	-
Hampshire, . . .	"	1	240	1	180	1	180
Worcester, . . .	"	11	2,753	12	4,788	11	5,094
Totals, . . .	.	16	3,801	17	$7,064	15	$6,614
Worcester, . . .	F.	2	548	2	$395	-	-
Folders.							
Hampden, . . .	M.	1	160	1	$160	-	-
Essex, ...	F.	4	844	3	$640	2	$450
Middlesex, . . .	"	18	4,186	18	4,134	11	2,382
Totals, . . .	.	22	5,030	21	$4,774	13	$2,832
Fullers.							
Hampden, . . .	M.	1	249	1	$403	1	$386
Giggers.							
Worcester, . . .	F.	4	900	4	$480	-	-
Harness Makers.							
Essex, ...	F.	8	1,956	9	$2,279	5	$940
Lapper Tenders.							
Worcester, . . .	M.	1	200	1	$212	1	$525
Loom Fixers.							
Bristol, ...	M.	22	5,465	23	$10,583	18	$9,042
Essex, ...	"	5	1,450	4	2,260	5	2,590
Hampden, . . .	"	10	2,665	11	4,767	6	2,823

FACTORY OPERATIVES—Continued.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Loom Fixers—*Con.*							
Hampshire, . . .	M.	1	275	1	$483	1	$400
Middlesex, . . .	"	15	4,175	12	6,765	13	6,164
Norfolk, . . .	"	2	525	2	974	2	1,204
Worcester, . . .	"	7	2,105	8	4,566	7	4,110
Totals, . . .	.	62	16,660	61	$30,398	52	$26,333
Measurers.							
Hampden, . . .	M.	1	300	1	$525	1	$525
Mule Spinners.							
Bristol, ...	M.	17	3,448	19	$6,355	11	$4,887
Essex, ...	"	10	2,466	8	2,976	6	2,086
Middlesex, . . .	"	4	890	4	1,105	3	860
Totals, . . .	.	31	6,804	31	$10,436	20	$7,833
Oilers.							
Essex, ...	M.	3	606	3	$835	3	$1,310
Overseers.							
Bristol, ...	M.	3	712	3	$2,187	3	$2,020
Hampden, . . .	"	4	1,182	4	3,358	3	2,000
Norfolk,. . . .	"	1	300	1	600	1	300
Totals, . . .	.	8	2,194	8	$6,145	7	$4,320
Packers.							
Essex, ...	M.	1	250	1	$250	1	$185
Middlesex, . . .	"	1	287	1	575	1	700
Totals, . . .	.	2	537	2	$825	2	$885
Picker Tenders.							
Berkshire, . . .	M.	1	250	1	$265	-	-
Hampden, . . .	"	6	1,700	6	1,996	5	$3,700
Worcester, . . .	"	4	1,020	4	1,490	3	1,250
Totals, . . .	.	11	2,970	11	$3,751	8	$4,950
Pressers.							
Middlesex, . . .	M.	1	300	1	$330	1	$500

FACTORY OPERATIVES—Continued.

Counties and Subdivisions of Occupations.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Scourers.							
Essex, ...	M.	1	270	1	$467	1	$450
Second Hands.							
Bristol, ...	M.	9	1,965	11	$7,066	9	$5,160
Section Hands.							
Essex, ...	M.	4	982	3	$1,450	2	$920
Slasher Tenders.							
Essex, ...	M.	1	262	1	$487	1	$551
Worcester, . . .	"	1	300	1	675	1	600
Totals, . . .	.	2	562	2	$1,162	2	$1,151
Speeder Tenders.							
Bristol, ...	M.	7	1,860	7	$2,051	1	$450
Bristol, ...	F.	28	6,760	29	$6,880	11	$1,793
Worcester, . . .	"	9	2,118	9	2,343	2	304
Totals, . . .	.	37	8,878	38	$9,223	13	$2,097
Spinners.							
Berkshire, . . .	M.	5	822	4	$869	3	$996
Bristol, ...	"	1	200	1	300	1	300
Essex, ...	"	17	4,307	17	8,863	17	8,927
Hampden, . . .	"	22	5,608	21	8,549	7	3,500
Hampshire, . . .	"	3	670	3	1,396	2	933
Norfolk, . . .	"	5	1,250	4	1,875	4	2,225
Worcester, . . .	"	51	13,082	53	19,781	46	17,623
Totals, . . .	.	104	25,939	103	$41,633	80	$34,504
Bristol, ...	F.	16	3,573	16	$3,689	10	$1,885
Essex, ...	"	37	8,942	35	8,617	8	1,731
Hampden, . . .	"	20	5,275	20	3,733	2	475
Middlesex, . . .	"	1	231	1	287	1	287
Norfolk, . . .	"	1	250	1	230	1	130
Worcester, . . .	"	21	5,079	19	2,931	16	2,335
Totals, . . .	.	96	23,350	92	$19,487	38	$6,843

FACTORY OPERATIVES—Continued.

Counties and Subdivisions of Occupations.	Sex.	Days Employed.		Yearly Wages.		Cos
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering
Spoolers.						
Bristol, ...	M.	2	450	2	$535	-
Bristol, ...	F.	26	6,085	26	$5,106	8
Essex, ...	"	43	10,418	45	8,919	15
Hampden, . . .	"	7	1,696	7	1,340	3
Middlesex, . . .	"	3	420	3	222	3
Norfolk, . . .	"	4	903	4	886	4
Worcester, . . .	"	14	3,365	15	2,124	8
Totals, . . .	.	97	22,887	100	$18,597	41
Stitchers.						
Middlesex, . . .	F.	2	320	2	$320	-
Undesignated.						
Berkshire, . . .	M.	27	6,751	32	$13,425	21
Bristol, ...	"	26	6,263	28	11,282	22
Essex, ...	"	191	47,667	187	70,989	126
Franklin, . . .	"	14	3,060	14	5,513	11
Hampden, . . .	"	44	11,141	43	813	30
Hampshire, . . .	"	2	340	2	733	2
Middlesex, . . .	"	60	14,312	60	20,663	38
Norfolk, . . .	"	18	4,842	18	9,523	16
Plymouth, . . .	"	22	4,523	23	8,208	14
Worcester, . . .	"	149	36,153	147	50,365	110
Totals, . . .	.	553	135,052	554	$191,514	390
Barnstable, . . .	F.	6	1,359	6	$835	5
Berkshire, . . .	"	9	2,204	9	2,029	7
Bristol, ...	"	33	7,546	33	7,322	18
Essex, ...	"	91	19,891	79	15,874	70
Franklin, . . .	"	3	790	3	600	3
Hampden, . . .	"	30	7,155	28	5,320	10
Hampshire, . . .	"	12	2,976	12	3,326	10
Middlesex, . . .	"	39	8,493	37	8,939	23

FACTORY OPERATIVES—CONCLUDED.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	SEX.	DAYS EMPLOYED.		YEARLY WAGES.		COST OF LIVING.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Undesignated—*Con.*							
Norfolk,	F.	5	1,266	4	$770	-	-
Worcester,	"	38	9,032	40	9,252	15	$2,912
Totals,	.	266	60,712	251	$54,267	161	$31,702
Warpers.							
Bristol,	F.	12	2,825	11	$2,620	7	$1,302
Essex,	"	11	2,329	10	2,279	9	1,984
Hampden,	"	3	900	3	810	1	200
Middlesex,	"	1	249	1	230	-	-
Worcester,	"	6	1,432	6	1,307	3	625
Totals,	.	33	7,735	31	$7,246	20	$4,111
Weavers.							
Berkshire,	M.	2	560	3	$885	1	$230
Bristol,	"	36	8,702	39	13,468	29	13,775
Essex,	"	49	11,721	55	14,302	31	9,602
Hampden,	"	47	12,131	46	13,447	21	6,764
Hampshire,	"	4	1,029	4	2,158	3	2,072
Norfolk,	"	10	2,351	10	3,909	9	3,709
Plymouth,	"	5	1,050	5	1,694	4	1,280
Worcester,	"	84	20,494	87	27,564	72	24,521
Totals,	.	237	58,038	249	$77,427	170	$61,943
Berkshire,	F.	6	1,015	6	$981	5	$638
Bristol,	"	142	33,316	146	43,443	78	17,294
Essex,	"	157	35,119	142	33,770	108	24,593
Franklin,	"	1	106	1	128	-	-
Hampden,	"	93	22,463	92	20,136	8	1,760
Hampshire,	"	5	930	5	1,122	2	625
Middlesex,	"	51	11,706	52	12,842	31	7,736
Norfolk,	"	2	400	2	700	2	390
Worcester,	"	158	37,223	162	36,650	81	18,945
Totals,	.	615	142,278	608	$149,772	315	$71,911

FARM LABORERS.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed.		Yearly Wages.	
		Number answering.	Aggregate.	Number answering.	Aggregate.
Barnstable, ...	M.	83	18,339	80	$21,109
Berkshire, ...	"	306	72,505	317	93,510
Bristol, ...	"	187	42,992	188	56,619
Dukes, ...	"	21	4,647	22	4,871
Essex, ...	"	329	82,000	336	115,357
Franklin, ...	"	162	38,149	160	44,235
Hampden, ...	"	273	67,328	280	93,456
Hampshire, ...	"	290	66,483	299	84,316
Middlesex, ...	"	609	151,350	629	212,700
Norfolk, ...	"	202	48,885	210	74,864
Plymouth, ...	"	217	46,470	216	60,552
Suffolk, ...	"	26	6,520	27	9,853
Worcester, ...	"	722	166,770	758	219,708
Totals, ...	.	3,427	812,438	3,522	$1,091,150

JEWELLERY MAKERS.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.
Barnstable, ...	M.	1	200	1	$400
Bristol, ...	"	418	83,936	425	196,236
Essex, ...	"	1	300	1	600
Hampden, ...	"	8	2,212	9	5,514
Middlesex, ...	"	5	1,102	5	1,949
Norfolk, ...	"	21	4,676	31	17,815
Suffolk, ...	"	2	400	2	767
Totals, ...	.	456	92,826	474	$223,281
Middlesex, ...	F.	3	776	3	$643
Norfolk, ...	"	1	200	1	270
Suffolk, ...	"	-	-	1	104
Totals, ...	.	4	976	5	$1,017

MACHINISTS.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Barnstable, . . .	M.	6	1,097	6	$2,807	5	$2,096
Berkshire, . . .	"	44	11,579	44	28,594	42	24,449
Bristol, ...	"	84	20,833	88	55,098	71	43,000
Dukes, ...	"	1	25	1	75	1	150
Essex, ...	"	135	36,776	133	80,058	102	59,309
Franklin, . . .	"	48	12,225	51	32,164	41	24,643
Hampden, . . .	"	194	51,919	188	133,999	169	111,647
Hampshire, . . .	"	31	7,204	31	18,380	23	14,995
Middlesex, . . .	"	442	113,967	437	265,897	371	219,684
Norfolk, ...	"	77	21,153	79	57,689	56	39,721
Plymouth, . . .	"	76	18,231	82	50,479	66	38,859
Suffolk, ...	"	188	47,060	184	132,455	135	86,409
Worcester, . . .	"	603	151,869	601	366,451	516	306,007
Totals, ...	.	1,929	493,938	1,925	$1,224,146	1,598	$970,969

MASONS.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Barnstable, . . .	M.	20	3,047	19	$8,443	20	$8,510
Berkshire, . . .	"	29	5,640	30	17,367	27	14,755
Bristol, ...	"	71	11,602	75	35,165	71	34,869
Dukes, ...	"	3	285	3	975	3	1,450
Essex, ...	"	101	17,942	101	52,926	84	43,539
Franklin, . . .	"	27	4,959	29	13,467	23	12,383
Hampden, . . .	"	99	19,056	97	53,596	71	38,494
Hampshire, . . .	"	25	4,357	26	12,820	21	9,416
Middlesex, . . .	"	220	41,675	234	125,451	197	106,308
Norfolk, ...	"	64	12,804	68	39,741	46	25,875
Plymouth, . . .	"	103	17,879	106	48,720	86	39,078
Suffolk, ...	"	101	21,523	106	69,492	81	43,801
Worcester, . . .	"	122	21,897	132	66,110	116	60,280
Totals, ...	.	985	182,666	1,026	$544,273	846	$438,758

PAINTERS.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	SEX.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Barnstable, . . .	M.	29	4,416	29	$10,567	28	$11,160
Berkshire, . . .	"	38	7,563	43	18,548	33	16,171
Bristol, ...	"	53	11,413	54	27,306	48	24,008
Dukes, ...	"	10	1,515	11	5,170	12	5,675
Essex, ...	"	108	22,445	109	51,753	77	36,387
Franklin, . . .	"	37	7,897	36	17,010	32	14,052
Hampden, . . .	"	101	22,459	106	51,493	77	36,924
Hampshire, . . .	"	16	3,139	16	7,241	12	5,211
Middlesex, . . .	"	237	52,231	239	124,138	196	102,682
Norfolk, ...	"	67	14,530	69	35,924	58	30,036
Plymouth, . . .	"	78	14,529	84	37,905	62	25,380
Suffolk, ...	"	118	25,677	123	63,201	81	41,352
Worcester, . . .	"	212	43,939	212	95,989	186	86,837
Totals, . . .	.	1,104	231,753	1,131	$546,245	902	$435,875

PAPER MAKERS.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	SEX.	Days Employed: Number answering.	Days Employed: Aggregate.	Yearly Wages: Number answering.	Yearly Wages: Aggregate.	Cost of Living: Number answering.	Cost of Living: Aggregate.
Assorters.							
Berkshire, . . .	M.	-	-	1	$350	1	$700
Middlesex, . . .	"	1	150	1	150	-	-
Totals, . . .	.	1	150	2	$500	1	$700
Berkshire, . . .	F.	23	5,198	24	$3,918	12	$2,821
Franklin, . . .	"	1	200	1	200	-	-
Hampden, . . .	"	8	1,840	8	2,463	5	1,369
Hampshire, . . .	"	2	400	2	450	2	450
Middlesex, . . .	"	4	725	4	558	1	75
Norfolk, ...	"	2	450	2	450	2	400
Totals, . . .	.	40	8,813	41	$8,039	22	$5,115
Bleachers.							
Middlesex, . . .	F.	-	-	1	$150	-	-

PAPER MAKERS—CONTINUED.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Boiler Tenders.							
Middlesex, . . .	M.	4	700	4	$1,264	-	-
Calenderers.							
Berkshire, . . .	F.	11	3,027	11	$2,214	7	$1,820
Hampshire, . . .	"*	1	250	1	375	1	375
Totals, . . .	.	12	3,277	12	$2,589	8	$2,195
Cutter Tenders.							
Middlesex, . . .	F.	4	925	5	$1,202	2	$600
Dyers.							
Middlesex, . . .	M.	-	-	1	$200	-	-
Engine Tenders.							
Berkshire, . . .	M.	21	6,089	22	$10,792	18	$7,062
Finishers.							
Berkshire, . . .	M.	8	2,226	8	$3,972	8	$3,775
Hampden, . . .	"	5	1,463	5	3,588	4	2,022
Middlesex, . . .	"	2	463	3	1,560	2	1,075
Totals, . . .	.	15	4,152	16	$9,120	14	$6,872
Hampden, . . .	F.	11	2,408	11	$3,081	11	$2,892
Middlesex, . . .	"	2	250	2	235	-	-
Totals, . . .	.	13	2,658	13	$3,316	11	$2,892
Machine Tenders.							
Berkshire, . . .	M.	10	3,015	10	$5,740	5	$2,850
Hampden, . . .	"	5	1,477	5	4,224	4	3,626
Hampshire, . . .	"	1	326	1	815	1	525
Middlesex, . . .	"	8	2,045	8	4,912	4	2,150
Totals, . . .	.	24	6,863	24	$15,691	14	$9,151
Hampden, . . .	F.	1	175	1	$437	-	-
Packers.							
Hampden, . . .	M.	1	280	1	$700	1	$700

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	D Number
Rag Cutters.		
Berkshire, . . .	M.	
Berkshire, . . .	F.	
Hampden, . . .	"	
Totals, . . .	.	
Rulers.		
Berkshire, . . .	M.	
Hampden, . . .	F.	
Size Makers.		
Hampshire, . . .	M.	
Undesignated.		
Berkshire, . . .	M.	8
Essex, ...	"	
Franklin, . . .	"	4
Hampden, . . .	"	7
Hampshire, . . .	"	3
Middlesex, . . .	"	5
Norfolk, ...	"	1
Worcester, . . .	"	3
Totals, . . .	.	34
Berkshire, . . .	F.	4
Essex, ...	"	1
Franklin, . . .	"	39
Hampden, . . .	"	22
Hampshire, . . .	"	22
Middlesex, . . .	"	5
Norfolk, . . .	"	5
Worcester, . . .	"	3
Totals, . . .	.	140

SHOEMAKERS.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Beaters Out.							
Essex, ...	M.	11	2,368	12	$5,521	9	$3,840
Binders.							
Essex, ...	F.	3	700	3	$500	3	$900
Blockers.							
Norfolk, ...	M.	2	380	2	$985	2	$975
Boot Liners.							
Norfolk, ...	F.	17	3,016	19	$1,890	7	$1,091
Boot Turners.							
Norfolk, ...	M.	8	1,765	9	$2,885	6	$2,163
Worcester, ...	"	5	1,164	5	2,318	5	2,876
Totals, ...	.	13	2,929	14	$5,203	11	$5,039
Bottomers.							
Bristol, ...	M.	4	667	4	$1,617	4	$1,880
Essex, ...	"	19	5,688	18	9,098	15	7,891
Franklin, ...	"	9	2,045	10	2,802	9	2,648
Middlesex, ...	"	10	2,081	10	4,162	5	3,602
Norfolk, ...	"	56	12,679	58	19,999	56	25,265
Plymouth, ...	"	21	4,266	24	8,571	21	8,873
Worcester, ...	"	313	69,347	326	125,704	290	119,699
Totals, ...	.	432	96,773	450	$171,953	400	$169,860
Buffers.							
Essex, ...	M.	6	1,305	6	$3,055	4	$2,104
Middlesex, ...	"	4	846	7	2,439	3	1,437
Worcester, ...	"	1	225	1	450	1	450
Totals, ...	.	11	2,376	14	$5,944	8	$3,991
Burnishers.							
Essex, ...	M.	3	745	4	$1,750	3	$836
Middlesex, ...	"	11	2,163	11	4,198	4	1,716

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Burnishers—Con.							
Norfolk, ...	M.	1	275	1	[illegible]	1	$600
Plymouth, ...	"	4	835	[illegible]	2,007	2	1,000
Totals, ...	.	19	4,018	20	$8,750	10	$4,152
Middlesex, ...	F.	1	280	1	$280	–	–
Channellers.							
Essex, ...	M.	11	2,324	11	$4,447	8	$4,450
Counter Makers.							
Worcester, ...	M.	3	587	3	$1,235	2	$790
Crimpers.							
Essex, ...	M.	3	770	3	$1,200	3	[illegible]
Middlesex, ...	"	9	1,900	9	3,806	6	2,950
Norfolk, ...	"	55	10,925	58	21,960	57	27,685
Plymouth, ...	"	17	2,788	17	6,984	14	7,210
Worcester, ...	"	76	17,569	76	36,582	66	32,275
Totals, ...	.	160	33,952	163	$70,532	146	[illegible]
Cutters.							
Bristol, ...	M.	11	2,404	12	$5,959	[illegible]	[illegible]
Essex, ...	"	254	61,745	267	139,226	205	120,122
Franklin, ...	"	2	550	2	687	2	600
Middlesex, ...	"	171	39,133	174	97,338	[illegible]	81,67[illegible]
Norfolk, ...	"	66	15,318	72	37,502	53	3[illegible]
Plymouth, ...	"	229	47,642	231	112,490	184	[illegible]
Worcester, ...	"	314	75,267	321	187,713	277	[illegible]
Totals, ...	.	1,047	242,059	1,079	$580,905	87[illegible]	[illegible]
Essex, ...	F.	1	260	1	$260	[illegible]	[illegible]
Worcester, ...	"	3	712	[illegible]	5[illegible]	[illegible]	[illegible]
Totals, ...	.	4	972	4	[illegible]	[illegible]	[illegible]

SHOEMAKERS—CONTINUED.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	SEX.	DAYS EMPLOYED.		YEARLY WAGES.		COST OF LIVING.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Dressers.							
Essex, ...	M.	14	3,318	15	$6,759	11	$6,769
Middlesex, . . .	"	11	2,366	11	4,852	10	5,029
Norfolk, . . .	"	7	1,450	7	2,597	5	2,875
Plymouth, . . .	"	22	4,108	20	6,476	11	4,468
Worcester, . . .	"	9	2,400	9	3,308	7	2,458
Totals, . . .	.	63	13,642	62	$23,992	44	$21,561
Middlesex, . . .	F.	3	650	5	$1,190	1	$160
Worcester, . . .	"	2	416	2	416	2	416
Totals, . . .	.	5	1,066	7	$1,606	3	$576
Edge Setters.							
Essex, ...	M.	19	4,244	21	$8,937	17	$7,527
Norfolk, . . .	"	28	6,142	30	13,167	29	14,747
Plymouth, . . .	"	40	8,267	40	20,801	30	16,912
Worcester, . . .	"	6	1,203	5	1,906	4	2,143
Totals, . . .	.	93	19,856	96	$44,811	80	$41,329
Eyeleters.							
Essex, ...	F.	4	887	4	$1,437	4	$908
Middlesex, . . .	"	10	1,742	11	1,817	5	1,283
Plymouth, . . .	"	5	1,185	5	1,575	3	1,235
Totals, . . .	.	19	3,814	20	$4,829	12	$3,426
Finishers.							
Berkshire, . . .	M.	1	242	1	$384	1	$200
Bristol, ...	"	2	475	2	1,125	2	1,000
Essex, ...	"	50	11,282	51	23,580	39	18,566
Franklin, . . .	"	-	-	1	375	1	375
Middlesex, . . .	"	111	23,841	116	54,087	102	53,794
Norfolk, . . .	"	71	15,049	74	30,255	68	29,169
Plymouth, . . .	"	85	16,794	88	39,444	62	31,803
Worcester, . . .	"	88	20,970	92	47,763	75	38,210
Totals, . . .	.	408	88,653	425	$197,013	350	$173,117

COUNTI AND SUBDIVIS OCCUPATI
Finishers-
Essex, . .
Middlesex, .
Totals, .
Fitters
Essex, . .
Middlesex, .
Norfolk, .
Plymouth, .
Suffolk, . .
Worcester, .
Totals, .
Essex, . .
Middlesex, .
Worcester, .
Totals, .
Foremen.
Norfolk, .
Heelers.
Essex, . .
Middlesex, .
Norfolk, .
Plymouth, .
Worcester, .
Totals, . .
Middlesex, . .
Norfolk, . .
Totals, . .
Inspectors.
Worcester, . .

SHOEMAKERS—CONTINUED.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Lasters.							
Bristol, ...	M.	8	1,480	8	$2,292	8	$2,906
Essex, ...	"	94	19,968	99	43,682	72	31,387
Middlesex, ...	"	101	19,153	107	40,930	83	37,315
Norfolk, ...	"	62	11,840	66	17,801	53	15,649
Plymouth, ...	"	101	19,960	101	41,673	56	21,714
Worcester, ...	"	75	15,417	92	31,748	73	25,906
Totals, ...	.	441	87,818	473	$178,126	345	$134,881
Essex, ...	F.	5	920	7	$1,404	2	$508
Middlesex, ...	"	1	260	1	325	1	325
Totals, ...	.	6	1,180	8	$1,729	3	$833
Levellers.							
Middlesex, ...	M.	8	1,681	7	$3,055	6	$3,935
Norfolk, ...	"	2	275	2	437	2	462
Plymouth, ...	"	3	550	3	725	1	300
Totals, ...	.	13	2,506	12	$4,217	9	$4,697
Machine Peggers.							
Worcester, ...	M.	3	850	3	$2,212	2	$1,400
McKay Stitchers.							
Bristol, ...	M.	1	150	1	$187	-	-
Norfolk, ...	"	1	300	1	750	1	$600
Totals, ...	.	2	450	2	$937	1	$500
Nailers.							
Bristol, ...	M.	5	748	7	$2,096	6	$1,600
Worcester, ...	"	4	725	4	1,048	4	1,450
Totals, ...	.	9	1,473	11	$3,144	10	$3,050
Packers.							
Essex, ...	M.	9	2,100	8	$3,324	5	$1,607
Middlesex, ...	"	12	2,668	12	5,849	12	5,658
Norfolk, ...	"	7	1,716	7	4,305	6	4,130

SHOEMAKERS—CONTINUED.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.
Packers—*Con.*					
Plymouth, ...	M.	11	2,474	11	$6,132
Worcester, ...	"	11	2,571	11	5,546
Totals, ...	.	50	11,529	49	$25,156
Pasters.					
Norfolk, ...	M.	2	350	2	$300
Essex, ...	F.	17	3,451	17	$4,557
Middlesex, ...	"	12	2,155	12	2,345
Norfolk, ...	"	6	1,262	6	815
Plymouth, ...	"	31	6,021	34	8,324
Worcester, ...	"	17	3,251	17	2,742
Totals, ...	.	83	16,140	86	$18,783
Peggers.					
Bristol, ...	M.	1	100	1	$350
Essex, ...	"	11	2,623	13	6,861
Middlesex, ...	"	26	5,879	30	18,326
Norfolk, ...	"	3	716	3	1,816
Plymouth, ...	"	33	6,570	30	16,282
Worcester, ...	"	24	5,379	24	12,601
Totals, ...	.	98	$21,267	101	$56,236
Pressers.					
Middlesex, ...	M.	3	809	3	$2,273
Essex, ...	F.	3	451	3	$388
Rosette Makers.					
Essex, ...	F.	4	950	4	$1,135
Sand Paperers.					
Middlesex, ...	M.	4	950	4	$1,925
Siders.					
Middlesex, ...	M.	2	533	2	$891
Norfolk, ...	"	1	300	2	725
Worcester, ...	"	40	9,617	43	23,350
Totals, ...	.	43	10,450	47	$24,966

SHOEMAKERS—Continued.

Counties and Subdivisions of Occupations.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Skivers.							
Middlesex, ...	M.	2	400	1	$450	2	$950
Worcester, ...	"	5	1,191	5	2,379	5	2,000
Totals, ...	.	7	$1,591	6	$2,829	7	$2,950
Middlesex, ...	F.	2	369	2	$350	2	$185
Stitchers.							
Essex, ...	M.	44	10,586	45	$23,336	29	$15,831
Franklin, ...	"	1	240	1	300	1	206
Middlesex, ...	"	13	2,853	13	5,425	10	3,220
Norfolk, ...	"	66	14,635	70	31,123	57	27,659
Plymouth, ...	"	76	17,082	80	42,252	59	30,103
Worcester, ...	"	19	4,020	20	8,217	14	6,349
Totals, ...	.	219	49,416	229	$110,653	170	$83,370
Berkshire, ...	F.	2	540	2	$810	2	$675
Essex, ...	"	163	32,887	176	47,523	81	20,837
Franklin, ...	"	2	550	2	619	1	200
Middlesex, ...	"	109	22,737	112	30,762	62	19,099
Norfolk, ...	"	10	2,123	10	2,772	9	1,987
Plymouth, ...	"	100	19,660	103	30,580	44	11,708
Suffolk, ...	"	1	275	1	307	1	500
Worcester, ...	"	87	20,137	93	24,303	64	14,491
Totals, ...	.	474	98,909	499	$137,676	264	$69,497
Stringers.							
Middlesex, ...	F.	4	735	4	$509	-	-
Treers.							
Essex, ...	M.	4	1,100	4	$2,050	4	$1,925
Franklin, ...	"	1	260	1	500	1	450
Middlesex, ...	"	19	4,255	19	8,900	14	6,650
Norfolk, ...	"	87	17,463	98	37,610	80	38,504

SHOEMAKERS—CONTINUED.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Treers—*Con.*							
Plymouth, . . .	M.	18	4,079	18	$9,700	11	$5,764
Worcester, . . .	"	181	43,858	187	100,531	167	87,633
Totals, . . .	.	310	71,015	327	$159,291	277	$140,926
Trimmers.							
Essex, ...	M.	32	7,635	34	$17,278	30	$16,130
Middlesex, . . .	"	54	11,121	58	26,598	49	26,803
Norfolk, . . .	"	2	394	2	863	2	775
Plymouth, . . .	"	17	3,627	21	8,481	14	6,458
Worcester, . . .	"	48	10,405	61	28,175	53	25,747
Totals, . . .	.	153	33,182	176	$81,395	148	$75,913
Essex, ...	F.	31	6,480	33	$9,218	13	$4,930
Middlesex, . . .	"	6	1,255	6	1,346	3	885
Totals, . . .	.	37	7,735	39	$10,564	16	$5,815
Undesignated.							
Barnstable, . . .	M.	5	1,080	5	$2,375	5	$2,610
Berkshire, . . .	"	23	5,148	31	18,549	27	15,544
Bristol, ...	"	74	13,803	81	29,923	72	32,020
Dukes, ...	"	5	1,050	5	1,242	5	1,600
Essex, ...	"	883	206,844	921	385,606	698	317,842
Franklin, . . .	"	15	3,480	15	5,500	13	4,136
Hampden, . . .	"	19	5,095	19	8,519	18	8,165
Hampshire, . . .	"	5	1,375	5	2,300	4	1,850
Middlesex, . . .	"	645	141,939	699	287,367	537	254,432
Norfolk, . . .	"	840	179,164	885	324,357	790	353,144
Plymouth, . . .	"	848	164,312	892	312,024	652	257,222
Suffolk, ...	"	72	18,051	71	38,296	64	26,993
Worcester, . . .	"	688	156,234	781	324,870	617	274,221
Totals, . . .	.	4,122	897,575	4,410	$1,740,928	3,492	$1,549,779

SHOEMAKERS—CONCLUDED.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	SEX.	DAYS EMPLOYED. Number answering.	DAYS EMPLOYED. Aggregate.	YEARLY WAGES. Number answering.	YEARLY WAGES. Aggregate.	COST OF LIVING. Number answering.	COST OF LIVING. Aggregate.
Undesignated—*Con.*							
Essex, ...	F.	14	3,085	13	$2,984	5	$960
Middlesex, . . .	"	78	15,101	80	15,474	40	10,737
Norfolk, ...	"	6	910	7	1,292	4	1,125
Plymouth, . . .	"	39	7,2 6	43	8,502	4	954
Suffolk, ...	"	2	624	2	468	-	-
Worcester, . . .	"	33	7,238	33	6,957	21	5,037
Totals, ...	.	172	34,194	178	$35,677	74	$18,813
Welters.							
Essex, ...	M.	2	500	2	$875	2	$875
Norfolk, ...	F.	1	175	1	$200	-	-

STRAW WORKERS.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	SEX.	DAYS EMPLOYED. Number answering.	DAYS EMPLOYED. Aggregate.	YEARLY WAGES. Number answering.	YEARLY WAGES. Aggregate.	COST OF LIVING. Number answering.	COST OF LIVING. Aggregate.
Bleachers.							
Hampden, ...	M.	-	-	-	-	1	$500
Norfolk, ...	"	4	858	4	$3,319	4	3,087
Totals, ...	.	4	858	4	$3,319	5	$3,587
Blockers.							
Hampden, ...	M.	1	200	1	$500	1	$575
Norfolk, ...	"	10	1,835	10	5,499	8	4,474
Worcester, . . .	"	15	2,803	15	6,930	15	6,943
Totals, ...	.	26	4,838	26	$12,929	24	$11,992
Finishers.							
Hampden, ...	M.	5	1,044	5	$3,423	3	$2,350
Norfolk, ...	"	1	125	1	312	1	650
Worcester, . . .	"	5	993	5	2,335	3	1,345
Totals, ...	.	11	2,162	11	$6,070	7	$4,345
Plymouth, . . .	F.	8	1,275	8	$1,155	8	$1,010
Worcester, . . .	"	8	1,279	8	1,693	2	650
Totals, ...	.	16	2,554	16	$2,848	10	$1,660

STRAW WORKERS—Continued.

Counties and Subdivisions of Occupations.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Machine Sewers.							
Hampden, . . .	F.	2	342	2	$527	1	$275
Worcester, . . .	"	5	801	5	1,184	1	108
Totals, . . .	.	7	1,143	7	$1,711	2	$383
Overseers.							
Hampden, . . .	M.	2	570	2	$2,607	2	$2,600
Norfolk, . . .	"	1	150	1	800	1	1,000
Totals, . . .	.	3	720	3	$3,407	3	$3,600
Pressers.							
Hampden, . . .	M.	4	776	4	$1,891	4	$2,850
Middlesex, . . .	"	1	50	1	150	1	500
Norfolk, . . .	"	11	1,989	12	5,533	11	5,450
Suffolk, ...	"	1	200	1	600	-	-
Worcester, . . .	"	12	2,260	12	5,168	9	4,125
Totals, . . .	.	29	5,275	30	$13,342	25	$12,925
Bristol, ...	F.	1	80	1	$80	1	$80
Sewers.							
Bristol, ...	F.	14	2,273	17	$1,714	5	$455
Hampden, . . .	"	20	2,681	20	4,218	14	3,055
Middlesex, . . .	"	1	75	1	75	1	75
Nantucket, . . .	"	2	160	2	130	2	170
Norfolk, . . .	"	154	22,543	174	18,850	69	13,349
Suffolk, ...	"	1	311	1	416	-	-
Worcester, . . .	"	43	6,345	45	5,318	13	2,422
Totals, . . .	.	235	34,388	260	$30,721	104	$19,526
Shapers.							
Plymouth, . . .	F.	1	130	1	$200	1	$175
Worcester, . . .	"	1	200	1	200	1	250
Totals, . . .	.	2	330	2	$400	2	$425

STRAW WORKERS—Concluded.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Trimmers.							
Hampden, ...	F.	6	921	6	$1,249	4	$802
Middlesex, ...	"	2	369	2	550	-	-
Plymouth, ...	"	1	100	1	150	1	100
Worcester, ...	"	3	475	3	632	2	312
Totals, ...	.	12	1,865	12	$2,581	7	$1,214
Undesignated.							
Hampden, ...	M.	5	1,025	5	$2,516	2	$1,737
Middlesex, ...	"	5	1,216	5	2,819	3	2,019
Norfolk, ...	"	47	12,691	57	27,930	40	22,568
Worcester, ...	"	35	7,932	33	15,215	26	15,004
Totals, ...	.	92	22,864	100	$48,480	71	$41,328
Barnstable, ...	F.	1	136	1	$170	1	$150
Hampden, ...	"	18	2,590	18	3,494	10	1,700
Middlesex, ...	"	5	925	6	856	1	200
Norfolk, ...	"	-	-	1	400	-	-
Plymouth, ...	"	3	542	3	562	3	437
Suffolk, ...	"	2	140	2	340	1	150
Worcester, ...	"	64	10,872	65	14,497	38	9,451
Totals, ...	.	93	15,205	96	$20,319	54	$12,148
Wirers.							
Bristol, ...	F.	2	300	3	$400	-	-
Hampden, ...	"	1	40	1	30	-	-
Plymouth, ...	"	1	100	1	100	1	$100
Worcester, ...	"	17	2,477	17	2,720	5	1,070
Totals, ...	.	21	2,917	22	$3,250	6	$1,170

TANNERS.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Beamsters.							
Middlesex, ...	M.	7	2,052	7	$3,434	6	$3,342
Dressers.							
Essex, ...	M.	3	550	4	$1,323	2	$673

TANNERS—CONTINUED.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.
Finishers.					
Essex, ...	M.	2	400	3	$1,200
Undesignated.					
Berkshire, . . .	M.	4	901	4	$1,920
Bristol, ...	"	1	260	1	520
Essex, ...	"	27	6,046	34	14,061
Franklin, . . .	"	1	300	1	465
Hampden, . . .	"	8	2,326	8	4,262
Middlesex, . . .	"	61	16,143	63	32,114
Norfolk, . . .	"	3	900	3	2,025
Plymouth, . . .	"	1	250	1	300
Worcester, . . .	"	3	813	3	2,450
Totals, . . .	.	109	27,939	118	$58,117

WHIP MAKERS.

Berkshire, . . .	M.	4	828	5	$2,104
Hampden, . . .	"	119	29,934	121	68,164
Hampshire, . . .	"	2	450	2	675
Totals, . . .	.	125	31,212	128	$70,943
Berkshire, . . .	F.	2	350	3	$362

WOOLLEN FACTORY OPERATIVES.

Assorters.					
Berkshire, . . .	M.	8	2,184	9	$4,873
Bristol, ...	"	2	375	3	1,587
Essex, ...	"	48	12,422	47	20,090
Franklin, . . .	"	2	600	2	705
Hampden, . . .	"	7	1,372	7	2,622
Hampshire, . . .	"	1	160	1	360
Middlesex, . . .	"	43	11,279	46	20,561

WOOLLEN FACTORY OPERATIVES—CONTINUED.

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Assorters—*Con.*							
Norfolk, ...	M.	2	458	3	$1,005	2	$950
Plymouth, . . .	"	4	519	4	806	4	1,850
Worcester, . . .	"	35	8,748	40	19,041	35	17,578
Totals, . . .	.	152	38,117	162	$71,650	130	$64,146
Burlers.							
Hampden, . . .	M.	1	220	1	$176	-	-
Essex, ...	F.	2	463	2	$492	1	$112
Hampden, . . .	"	7	1,915	7	1,815	6	1,388
Totals, . . .	.	9	2,378	9	$2,307	7	$1,500
Carders.							
Berkshire, . . .	M.	1	100	1	$50	-	-
Bristol, ...	"	-	-	1	528	1	$528
Essex, ...	"	3	762	3	2,536	3	2,536
Franklin, . . .	"	3	468	3	574	-	-
Hampden, . . .	"	6	1,683	6	3,596	6	3,625
Middlesex, . . .	"	25	6,340	25	11,293	17	8,901
Norfolk, . . .	"	7	1,905	7	3,293	6	2,718
Worcester, . . .	"	42	10,045	40	14,685	36	13,661
Totals, . . .	.	87	21,303	86	$36,555	69	$31,969
Combers.							
Essex, ...	M.	3	870	3	$1,635	2	$474
Drawers In.							
Hampden, . . .	F.	-	-	1	$240	1	$150
Dressers.							
Berkshire, . . .	M.	2	508	2	$992	2	$900
Essex, ...	"	10	2,189	8	4,002	6	3,317
Franklin, . . .	"	2	575	2	1,012	2	1,000
Hampden, . . .	"	4	1,123	4	1,866	4	1,642
Middlesex, . . .	"	8	2,118	9	4,087	7	3,144
Norfolk, . . .	"	1	300	1	1,200	1	900

Counties and Subdivisions of Occupations.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Dressers—*Con.*							
Plymouth, . . .	M.	1	250	1	$627	1	$490
Worcester, . . .	"	2	525	2	600	-	-
Totals, . . .	.	30	7,588	29	$14,395	23	$11,263
Middlesex, . . .	F.	1	240	2	$490	1	$300
Dyers.							
Berkshire, . . .	M.	6	1,611	5	$2,270	4	$1,720
Essex, ...	"	22	5,327	18	7,658	18	8,113
Franklin, . . .	"	1	250	1	500	1	400
Hampden, . . .	"	9	2,600	9	5,015	4	2,760
Middlesex, . . .	"	48	11,699	45	[illegible]	36	21,494
Plymouth, . . .	"	1	236	1	626	1	626
Worcester, . . .	"	34	8,706	33	16,086	31	12,061
Totals, . . .	.	121	30,429	112	$58,251	95	$47,364
Finishers.							
Berkshire, . . .	M.	4	1,010	4	[illegible]	4	$1,525
Bristol, ...	"	1	[illegible]	1	900	1	1,100
Franklin, . . .	"	1	300	1	600	1	600
Hampden, . .	"	10	2,646	10	4,586	5	[illegible]
Middlesex, . . .	"	15	3,615	15	5,211	9	2,660
Norfolk, . . .	"	2	606	2	1,422	2	977
Plymouth, . . .	"	2	370	2	860	2	1,000
Totals, . . .	.	35	8,849	35	$15,209	24	$9,972
Berkshire, . . .	F.	1	205	1	$205	1	$205
Middlesex, . . .	"	2	300	1	75	2	275
Totals, . . .	.	3	505	2	$280	3	$480
Folders.							
Middlesex, . . .	F.	2	490	2	$441	2	$300
Fullers.							
Berkshire, . . .	M.	2	525	2	$765	2	$405
Essex, ...	"	1	308	1	372	-	-

WOOLLEN FACTORY OPERATIVES—Continued.

Counties and Subdivisions of Occupations.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Fullers—Con.							
Hampshire,	M.	1	312	1	$546	1	$450
Norfolk,	"	1	308	1	500	-	-
Plymouth.	"	1	274	1	411	1	600
Worcester,	"	7	1,673	7	1,794	7	2,066
Totals,	.	13	3,400	13	$4,388	11	$3,540
Giggers.							
Berkshire,	M.	7	1,355	10	$1,961	7	$2,720
Essex,	"	9	2,462	9	3,127	4	3,218
Hampden,	"	5	1,490	5	2,216	2	[illegible]
Middlesex,	"	2	500	2	616	1	300
Worcester,	"	11	2,669	10	2,564	9	4,260
Totals,	.	34	8,476	36	$10,484	23	$11,104
Loom Fixers.							
Berkshire,	M.	1	305	1	$672	1	$1,000
Essex,	"	3	830	3	1,588	2	1,080
Franklin,	"	1	300	1	600	-	-
Norfolk,	"	1	225	1	450	1	450
Worcester,	"	28	6,911	28	12,161	25	10,467
Totals,	.	34	8,571	34	$15,471	29	$12,997
Oilers.							
Essex,	M.	1	350	-	-	1	$880
Worcester,	"	2	523	2	$838	1	450
Totals,	.	3	873	2	$838	2	$1,330
Overseers.							
Hampden,	M.	1	287	2	$1,525	2	$1,150
Picker Tenders.							
Berkshire,	M.	1	300	1	$450	1	$450
Essex,	"	3	813	4	700	-	-
Franklin,	"	1	300	1	375	1	400
Hampden,	"	-	-	1	400	1	200

WOOLLEN FACTORY OPERATIVES—Continued.

Counties and Subdivisions of Occupations.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages. Number answering.	Yearly Wages. Aggregate.	Cost of Living. Number answering.	Cost of Living. Aggregate.
Picker Tenders—*Con.*							
Middlesex, . . .	M.	5	1,291	5	$3,212	4	$1,935
Worcester, . . .	"	11	2,715	11	2,700	9	4,000
Totals, . . .	.	21	5,419	23	$7,837	16	$6,985
Pressers.							
Worcester, . . .	M.	15	3,715	15	$3,681	15	$4,564
Middlesex, . . .	F.	4	1,045	4	$1,124	3	$736
Reelers.							
Essex, ...	F.	10	2,749	7	$1,909	9	$2,066
Middlesex, . . .	"	5	1,350	8	1,946	6	1,075
Worcester, . . .	"	5	900	5	410	-	-
Totals, . . .	.	20	4,999	20	$4,265	15	$3,141
Scourers.							
Berkshire, . . .	M.	1	100	1	$450	1	$300
Essex, ...	"	1	312	1	441	-	-
Hampden, . . .	"	1	300	1	450	1	450
Middlesex, . . .	"	5	1,374	4	1,415	4	1,734
Norfolk, . . .	"	3	780	4	920	4	2,240
Worcester, . . .	"	7	1,751	7	2,092	6	1,615
Totals, . . .	.	18	4,617	18	$5,768	16	$6,339
Shearers.							
Hampden, . . .	M.	3	878	3	$1,322	1	$240
Worcester, . . .	"	2	575	1	300	1	200
Totals, . . .	.	5	1,453	4	$1,622	2	$440
Speckers.							
Plymouth, . . .	F.	1	130	1	$130	1	$225
Spinners.							
Berkshire, . . .	M.	9	2,309	9	$3,629	6	$2,950
Essex, ...	"	20	4,241	19	5,385	12	5,370
Franklin, . . .	"	4	1,200	4	1,825	4	1,575

WOOLLEN FACTORY OPERATIVES—Continued.

Counties and Subdivisions of Occupations.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Spinners—*Con.*							
Hampden, . . .	M.	12	2,767	12	$4,689	9	$3,450
Middlesex, . . .	"	64	12,798	60	23,097	45	23,429
Norfolk, . . .	"	1	300	1	600	1	500
Plymouth, . . .	"	13	2,608	14	3,888	12	3,879
Worcester, . . .	"	36	8,266	39	14,367	30	12,804
Totals, . . .	.	159	34,489	158	$57,480	119	$53,957
Berkshire, . . .	F.	2	379	2	$359	2	$249
Essex, ...	"	1	260	1	260	1	260
Hampden, . . .	"	1	250	1	225	1	225
Middlesex, . . .	"	4	992	4	800	-	-
Norfolk, . . .	"	2	432	2	341	2	560
Worcester, . . .	"	2	470	2	296	2	226
Totals, . . .	.	12	2,783	12	$2,281	8	$1,520
Spoolers.							
Middlesex, . . .	M.	2	148	2	$53	2	$60
Plymouth, . . .	"	1	230	1	400	1	400
Totals, . . .	.	3	378	3	$453	3	$460
Hampden, . . .	F.	2	576	2	$394	1	$150
Stitchers.							
Middlesex, . . .	F.	60	14,725	64	$16,218	61	$11,277
Teazle Setters.							
Berkshire, . . .	M.	2	450	2	$400	1	$200
Twisters.							
Essex, ...	M.	5	1,116	4	$1,195	3	$1,066
Essex, ...	F.	1	208	1	$180	1	$180
Middlesex, . . .	"	2	442	2	602	-	-
Totals, . . .	.	3	650	3	$782	1	$180

WOOLLEN FACTORY OPERATIVES—Cont

COUNTIES AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Days Employed. Number answering.	Days Employed. Aggregate.	Yearly Wages Number answering.	Yearly Wages Aggregate.
Undesignated.					
Berkshire, ...	M.	1	312	1	$39
Bristol, ...	"	2	500	2	83
Hampden, ...	"	18	3,919	18	6,44
Middlesex, ...	"	56	13,037	54	19,46
Norfolk, ...	"	11	2,934	10	4,91
Plymouth, ...	"	1	300	1	45
Worcester, ...	"	5	1,420	6	4,56
Totals, ...	.	94	22,422	92	$37,06
Hampden, ...	F.	5	1,253	5	$1,23
Middlesex, ...	"	22	4,780	22	4,63
Plymouth, ...	"	1	64	1	8
Worcester, ...	"	15	3,199	15	3,07
Totals, ...	.	43	9,296	43	$9,03
Warpers.					
Norfolk, ...	M.	1	300	1	$60
Worcester, ...	"	1	112	1	15
Totals, ...	.	2	412	2	$75
Middlesex, ...	F.	1	225	1	$22
Weavers.					
Berkshire, ...	M.	26	7,252	30	$14,67
Bristol, ...	"	1	280	1	42
Essex, ...	"	31	8,119	33	11,72
Franklin, ...	"	9	2,475	9	3,51
Hampden, ...	"	19	4,639	19	7,48
Middlesex, ...	"	36	9,915	46	15,81
Worcester, ...	"	37	8,200	41	12,53
Totals, ...	.	159	40,880	179	$66,16

WOOLLEN FACTORY OPERATIVES—Concluded.

Counties and Subdivisions of Occupations.	Sex.	Days Employed.		Yearly Wages.		Cost of Living.	
		Number answering.	Aggregate.	Number answering.	Aggregate.	Number answering.	Aggregate.
Weavers—*Con.*							
Berkshire, ...	F.	20	4,943	22	$5,159	11	$1,907
Essex, ...	"	43	10,976	41	10,784	30	6,300
Franklin, ...	"	1	300	1	225	1	200
Hampden, ...	"	21	5,050	19	5,214	13	3,114
Middlesex, ...	"	133	29,901	127	26,889	82	14,756
Norfolk, ...	"	-	-	2	650	2	120
Plymouth, ...	"	9	2,380	9	3,450	9	2,465
Worcester, ...	"	12	2,688	9	1,580	4	705
Totals, ...	.	239	56,238	230	$53,951	152	$29,597

Exhibit of Averages.

The following pages of this chapter show the
days employed, *yearly wages* and *cost of living*, b
all the persons following the occupations enum
have returned schedules to us.

That no one may fall into the error of ascribing
to all these averages, the reader is referred to th
pages of aggregates, where he can find the basis
each average is deduced. A few are drawn fr
received from but a small number of persons, w
are derived from the returns of more than four th

Average for each Person answering each Inquir

OCCUPATIONS AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Average of Days Employed.	Average of Yearly Wages.
Armorers,	M.	266.19	$700 89
Blacksmiths,	"	256.71	574 25
Cabinet makers,	"	242.14	545 06
Carpenters,	"	218.55	539 40
Chair makers:			
Cane seaters,	"	162.14	51 28
" "	F.	198.43	97 06
Finishers,	M.	272.60	494 40
Ornamenters,	"	300.00	600 00
"	F.	260.00	325 00
Sawyers,	M.	200.00	673 00
Stock turners,	"	185.00	375 00
Undesignated,	"	238.79	450 36
Common laborers,	"	225.10	367 16
Cotton factory operatives:			
Assorters,	"	300.00	600 00
Beamers,	"	225.00	400 00

Average for each Person answering each Inquiry—Continued.

OCCUPATIONS AND SUBDIVISIONS OF OCCUPATIONS.	SEX.	Average of Days Employed.	Average of Yearly Wages.	Average of Cost of Living.
Cotton factory operatives—*Con.*				
Carders,	M.	257.63	$419 25	$463 50
"	F.	251.62	229 93	182 31
Card grinders,	M.	273.13	404 35	372 00
Card strippers,	"	242.46	287 23	369 60
" "	F.	300.00	300 00	300 00
Cloth trimmers,	"	175.00	160 00	300 00
Drawers in,	M.	225.00	282 50	322 00
"	F.	196.67	173 33	96 00
Dressers,	M.	264.00	493 36	524 54
"	F.	264.71	334 71	568 50
Dyers,	M.	251.14	533 57	479 83
Finishers,	"	255.06	447 63	477 27
"	F.	175.00	156 50	138 50
Folders,	M.	300.00	675 00	-
"	F.	246.50	239 50	167 50
Inspectors,	"	280.00	217 50	175 00
Lapper tenders,	M.	218.66	315 00	400 00
Loom fixers,	"	236.18	398 50	516 17
Mule spinners,	"	296.75	555 22	435 00
Oilers,	"	100.90	334 75	513 33
Overseers,	"	280.43	697 00	600 00
Packers,	F.	200.00	144 00	-
Picker tenders,	M.	250.90	324 10	496 55
" "	F.	226.27	231 45	199 18
Quillers,	"	234.00	156 00	140 00
Second hands,	M.	250.00	500 00	400 00
Section hands,	"	225.00	450 00	500 00
Slasher tenders,	"	262.40	492 93	308 50
Speeder tenders,	"	286.00	430 00	600 00
" "	F.	234.43	247 68	236 89

OCCUPATIONS AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Average of Days Employed.	Average of Yearly Wages.	Average of Cost of Living.
Cotton factory operatives—*Con.*				
Spinners,	M.	255.71	$461 16	$467 67
"	F.	252.23	219 93	177 29
Spoolers,	M.	305.50	421 50	506 58
"	F.	237.25	192 06	175 16
Undesignated,	M.	262.11	430 66	454 76
"	F.	315.17	168 33	190 83
Warpers,	"	258.21	233 24	187 00
Weavers,	M.	238.81	370 18	405 65
"	F.	239.23	249 67	207 87
Web drawers,	"	289.52	223 27	160 22
Winders,	M.	-	-	200 60
"	F.	294.00	293 00	-
Curriers:				
Beamsters,	M.	-	260 00	260 00
Buffers,	"	310.00	600 00	500 00
Finishers,	"	248.03	467 97	446 65
Measurers,	"	299.50	792 00	833 33
Morocco dressers,	"	263.95	593 05	632 78
Scourers,	"	325.00	487 00	500 00
Splitters,	"	270.33	967 17	613 33
Stuffers,	"	235.43	451 14	464 17
Tablemen,		221.10	435 78	368 75
Undesignated,	"	246.56	475 84	472 46
Cutlers:				
Blade oilers,	"	260.00	260 00	260 00
Bolster droppers,	"	250.00	500 00	500 00
Finishers,	"	219.22	348 44	408 89
Forgers,	"	196.67	431 25	485 00
Grinders,	"	206.60	378 46	635 96
Hafters,	"	197.00	358 00	680 00

Average for each Person answering each Inquiry—Continued.

OCCUPATIONS AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Average of Days Employed.	Average of Yearly Wages.	Average of Cost of Living.
Cutlers—*Con.*				
Handle riveters,	M.	150.00	$300 00	$375 00
Handle sawyers,	"	260.00	588 50	685 00
Knife cleaners,	F.	230.00	230 00	170 00
Polishers,	M.	225.00	394 00	394 00
Temperers,	"	208.00	512 00	1,024 00
Undesignated,	"	235.69	454 51	484 98
Domestic servants,	F.	319.34	161 18	132 93
Factory operatives:				
Beamers,	M.	-	-	500 00
Burlers,	F.	245.27	173 82	230 00
Carders,	M.	260.30	411 68	434 16
"	F.	240.71	195 58	214 83
Card grinders,	M.	255.64	373 53	489 30
Card inspectors,	F.	-	300 00	300 00
Card strippers,	M.	235.50	300 37	366 40
Cloth trimmers,	F.	230.61	228 29	267 75
Doffers,	M.	110.00	110 00	-
Drawers in,	"	256.50	300 00	345 00
" "	F.	233.85	228 72	214 81
Dressers,	M.	255.64	458 53	571 75
Dyers,	"	200.20	555 20	340 00
Finishers,	"	237.56	415 53	440 93
"	F.	274.00	197 50	-
Folders,	M.	160.00	160 00	-
"	F.	228.64	227 33	217 85
Fullers,	M.	249.00	403 00	386 00
Giggers,	F.	225.00	120 00	-
Harness makers,	"	244.50	253 22	188 00
Lapper tenders,	M.	200.00	212 00	525 00
Loom fixers,	"	268.71	498 33	506 40

Average for each Person answering each Inquiry—Continued.

OCCUPATIONS AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Average of Days Employed.	Average of Yearly Wages.	Average of Cost of Living.
Factory operatives—*Con.*				
Measurers,	M.	300.00	$525 00	$525 00
Mule spinners,	"	219.48	336 64	391 65
Oilers,	"	202.00	278 33	436 67
Overseers,	"	274.25	768 12	617 14
Packers,	"	268.50	412 50	442 50
Picker tenders,	"	270.00	341 60	618 75
Pressers,	"	300.00	330 00	500 00
Scourers,	"	270.00	467 00	450 00
Second hands,	"	218.33	642 36	573 33
Section hands,	"	245.50	483 33	460 00
Slasher tenders,	"	281.00	581 00	575 50
Speeder tenders,	"	265.71	293 00	450 00
" "	F.	239.94	242 71	161 31
Spinners,	M.	249.41	404 20	431 30
"	F.	243.23	211 81	180 08
Spoolers,	M.	225.00	267 50	-
"	F.	235.95	185 97	172 34
Stitchers,	"	160.00	160 00	-
Undesignated,	M.	244.22	345 69	470 13
"	F.	228.24	216 20	196 91
Warpers,	"	234.39	233 74	205 55
Weavers,	M.	244.89	310 95	364 37
"	F.	231.35	246 33	228 29
Farm laborers,	M.	237.07	309 81	338 22
Jewellery makers,	"	203.56	471 06	497 04
" "	F.	244.00	203 40	249 80
Machinists,	M.	256.06	635 92	607 62
Masons,	"	185.45	530 48	518 62
Painters,	"	209.92	482 98	483 23

Average for each Person answering each Inquiry—Continued.

OCCUPATIONS AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Average of Days Employed.	Average of Yearly Wages.	Average of Cost of Living.
Paper makers:				
Assorters,	M.	150.00	$250 00	$700 00
"	F.	220.32	196 07	232 50
Bleachers,	"	-	150 00	-
Boiler tenders,	M.	175.00	316 00	-
Calenderers,	F.	273.08	215 75	274 37
Cutter tenders,	"	231.25	240 40	300 00
Dyers,	M.	-	200 00	-
Engine tenders,	"	289.95	490 54	392 33
Finishers,	"	276.80	570 00	490 86
"	F.	204.46	255 08	262 91
Machine tenders,	M.	285.96	653 79	653 64
" "	F.	175.00	437 00	-
Packers,	M.	280.00	700 00	700 00
Rag cutters,	"	227.50	293 25	307 50
"	F.	222.22	148 04	246 82
Rulers,	M.	250.00	700 00	700 00
"	F.	247.00	288 67	-
Size makers,	M.	225.00	450 00	500 00
Undesignated,	"	269.27	540 55	523 59
"	F.	245.53	240 00	220 48
Shoemakers:				
Beaters out,	M.	215.27	460 08	426 67
Binders,	F.	233.33	166 67	300 00
Blockers,	M.	190.00	492 50	487 50
Boot liners,	F.	177.41	99 47	155 86
Boot turners,	M.	225.31	371 64	458 09
Bottomers,	"	224.01	382 12	424 65
Buffers,	"	216.00	424 57	498 88
Burnishers,	"	211.47	439 00	415 20
"	F.	280.00	280 00	-

Average for each Person answering each Inquiry—Continued.

OCCUPATIONS AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Average of Days Employed.	Average of Yearly Wages.	Average of Cost of Living.
Shoemakers—*Con.*				
Channellers,	M.	211.27	$404 27	$556 25
Counter makers,	"	195.67	411 67	395 00
Crimpers,	"	212.20	432 71	489 73
Cutters,	"	231.19	588 37	548 58
"	F.	243.00	198 25	200 00
Dressers,	M.	216.54	386 97	490 48
"	F.	213.20	229 43	192 00
Edge setters,	M.	213.51	466 78	516 61
Eyeleters,	F.	200.74	241 20	285 50
Finishers,	M.	217.29	463 56	494 62
"	F.	205.00	256 67	191 67
Fitters,	M.	241.17	498 86	514 57
"	F.	226.29	283 71	247 85
Foremen,	M.	305.00	987 50	805 00
Heelers,	"	216.15	447 62	477 51
"	F.	263.14	333 00	277 20
Inspectors,	M.	256.00	582 00	520 00
Lasters,	"	199.13	376 59	390 96
"	F.	196.67	216 12	277 67
Levellers,	M.	192.77	351 42	521 89
Machine peggers,	"	283.33	737 33	700 00
McKay stitchers,	"	225.00	468 50	500 00
Nailers,	"	163.67	285 82	305 00
Packers,	"	230.58	513 39	517 07
Pasters,	"	175.00	150 00	100 00
"	F.	194.46	218 41	217 15
Peggers,	M.	217.01	556 79	543 61
Pressers,	"	269.67	757 67	761 00
"	F.	150.33	129 33	86 00
Rosette makers,	"	237.50	283 75	210 00

Average for each Person answering each Inquiry—Continued.

OCCUPATIONS AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Average of Days Employed.	Average of Yearly Wages.	Average of Cost of Living.
Shoemakers—*Con.*				
Sand paperers,	M.	237.50	$481 25	$550 00
Siders,	"	243.02	531 19	538 51
Skivers,	"	227.28	471 50	421 43
"	F.	184.50	175 00	92 50
Stitchers,	M.	225.64	483 20	490 41
"	F.	208.67	275 90	263 25
Stringers,	"	183.75	127 25	-
Treers,	M.	229.08	487 13	508 76
Trimmers,	"	216.87	462 47	512 92
"	F.	209.05	270 87	363 44
Undesignated,	M.	217.75	394 77	443 81
"	F.	198.80	200 43	234 23
Welters,	M.	250.00	437 50	437 50
"	F.	175.00	200 00	-
Straw workers:				
Bleachers,	M.	214.50	829 75	717 40
Blockers,	"	186.06	497 27	499 67
Finishers,	"	196.54	551 82	620 71
"	F.	159.62	178 00	166 00
Machine sewers,	"	163.28	244 43	191 50
Overseers,	M.	240.00	1,135 66	1,200 00
Pressers,	"	181.90	444 73	517 00
"	F.	80.00	80 00	80 00
Sewers,	"	146.33	118 16	187 75
Shapers,	"	165.00	200 00	212 50
Trimmers,	"	155.42	215 08	173 43
Undesignated,	M.	248.52	484 80	582 08
"	F.	163.49	211 66	224 96
Wirers,	"	138.90	147 73	196 00

Average for each Person answering each Inquiry—Continued.

OCCUPATIONS AND SUBDIVISIONS OF OCCUPATIONS.	Sex.	Average of Days Employed.	Average of Yearly Wages.	Average of Cost of Living.
Tanners:				
Beamsters,	M.	293.14	$490 57	$557 00
Dressers,	"	183.33	330 75	336 50
Finishers,	"	200.00	400 00	750 00
Undesignated,	"	256.32	492 52	533 49
Whip makers,	"	249.70	554 24	568 79
" "	F.	175.00	120 67	150 00
Woollen factory operatives:				
Assorters,	M.	250.77	442 28	493 43
Burlers,	"	220.00	176 00	-
"	F.	264.22	256 33	214 28
Carders,	M.	244.86	425 06	463 32
Combers,	"	290.00	545 00	237 00
Drawers in,	F.	-	240 00	150 00
Dressers,	M.	252.93	496 07	494 91
"	F.	240.00	245 00	300 00
Dyers,	M.	251.48	520 09	498 57
Finishers,	"	252.83	434 54	415 50
"	F.	168.33	140 00	160 00
Folders,	"	245.00	220 50	150 00
Fullers,	M.	261.54	337 54	321 82
Giggers,	"	249.29	291 22	482 78
Loom fixers,	"	252.09	455 03	448 17
Oilers,	"	291.00	419 00	665 00
Overseers,	"	287.00	762 50	575 00
Picker tenders,	"	258.05	340 74	436 56
Pressers,	"	247.67	245 40	304 27
"	F.	261.25	281 00	245 33
Reelers,	"	249.95	213 25	209 40
Scourers,	M.	256.50	320 44	396 19
Shearers,	"	290.60	405 50	220 00

PART II.

SALARY RECEIVERS.

CHAPTER I.

OCCUPATIONS AND PRESENTATION BY SCHEDULE QUESTIONS.

Before presenting the tabulations of the schedules received from the salaried workers of the State, we give, as in the case of the wage workers, a list of the occupations pursued by the various persons belonging to this class who have filled out, more or less fully, the Individual Schedules, from which the tables have been made up.

We need not repeat what we said in the beginning of Part I., in reference to the course pursued in assorting all schedules into two classes,—one representing those persons working for a yearly salary, and the other those working for a daily wage. We explained, in that place, with sufficient clearness, the plan adopted.

There are a few employments mentioned in the list that follows that probably stand for but a single person, or, at most, for but half a dozen, the great mass of individuals belonging to those occupations being tabulated among wage receivers.

The master mariners, marine engineers, and travelling salesmen enumerated, of course receive board in addition to their salaries. These are believed to be the only occupations, reckoned as salaried, in which board is given, and they include the returns of only a few persons.

There are occasional instances of employments included, which would seem, at first thought, to belong in the catalogue of those who do business on their own account, rather than receive salaries,—as, for instance, *lawyer;* but the very

few lawyers whose schedules have been used were undoubtedly those receiving a salary. And so of some other employments which might seem, to the superficial reader, to have deserved rejection.

Under the head of city and town, county, State, United States, bank, corporation, railroad and express officials, are included representatives of nearly one hundred and fifty different occupations which it was not thought worth while to specify more exactly.

For a more full explanation of what is presented in this chapter, see Part I., Chap. I.

Occupations of Salaried Persons from whom Schedules were Received.

Actor.
Actress.
Agent.
Architect.
Auctioneer.
Bank officials.
Bar tender.
Book-keeper.
Buyer.
Cashier.
Chemist.
City and town officials.
Civil engineer.
Clergyman.
Clerk.
Collector.
College president.
College professor.
Commissioner of Chinese education.
Copy holder.
Copyist.
Dentist.
Designer (pattern).
Draughtsman.
Drawbridge tender.
Dyer.
Engineer (stationary).
Engineer (mechanical).
Engraver.
Express officials.
Fireman (stationary).
Florist.
Floor walker.
Horse trainer.
Hotel cook.
Insurance agent.
Insurance officials.
Janitor.
Journalist.
Lady's companion.
Lawyer.
Leather inspector.
Librarian.
Librarian's assistant.
Machinist.
Managing editor
Master mariner.
Master mechanic.
Matron.
Musician
Nurse.
Organist.
Overseer.
Physician (hospital).
Piano tuner.
Proof reader.
Railroad officials.
Reporter.
Salesman.
Salesman (travelling).
Secretary of foreign missions.
Sexton.
Shipper.
State officials.
Steam fitter.
Stenographer.
Steward.
Tailor (cutter).
Teacher (private school).
Telegraph constructor.
Telegraph manager.
Telegraph operator.
Time keeper.
United States officials.
Vocalist.
Wharfinger.

Presentation by Schedule Questions.

[Note.—For an explanation of what these tables are intended to show, see page 14, *Presentation by Schedule Questions*. On page 16, *et seq.*, can be found a similar presentation respecting *wage* laborers. The facts presented in these tables refer to *salaried* persons.]

Persons Dependent on Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . .	177	130	73	342	2.63
Berkshire, . . .	168	108	64	317	2.93
Bristol, . . .	335	225	67	638	2.84
Dukes, . . .	45	43	96	118	2.74
Essex, . . .	616	420	68	1,152	2.74
Franklin, . . .	132	95	72	242	2.55
Hampden, . . .	611	450	74	1,187	2.64
Hampshire, . .	106	79	75	222	2.81
Middlesex, . . .	1,957	1,391	71	3,627	2.61
Nantucket, . . .	17	12	71	28	2.33
Norfolk, . . .	423	310	73	884	2.85
Plymouth, . . .	317	220	69	583	2.65
Suffolk, . . .	1,616	959	59	2,434	2.54
Worcester, . . .	1,228	807	66	2,097	2.60
For the State, .	7,748	5,249	68	13,871	2.64

This question, as it was originally asked in the Individual Schedules which were left with each salaried and wage laborer of the State, was, "Number depending upon you for support." And the answers were expected to state the number of adults and the number of children separately. But it has not been thought best to preserve this distinction in the presentation, as we had good reason to believe that many had returned as children those who were of nearly or quite adult

Persons Dependent on Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable, . . .	52	2	4	3	1.50
Berkshire, . . .	58	3	5	3	1.00
Bristol, . . .	64	2	3	2	1.00
Dukes, . . .	10	1	10	1	1.00
Essex, . . .	204	17	8	19	1.12
Franklin, . . .	50	1	2	1	1.00
Hampden, . . .	127	12	9	18	1.50
Hampshire, . .	61	5	8	5	1.00
Middlesex, . . .	398	32	8	51	1.59
Nantucket, . . .	3	-	-	-	-
Norfolk, . . .	131	10	8	17	1.70
Plymouth, . . .	70	3	4	6	2.00
Suffolk, . . .	231	34	15	75	2.20
Worcester, . . .	347	30	9	48	1.60
For the State, .	1,806	152	8	249	1.63

age; and for the additional reason, that it was sometimes impossible to determine whether the dependents were adults or children.

Five thousand two hundred and forty-nine males answered this question, or 68 per cent of the whole number returning schedules; 152 females answered, or 8 per cent of the whole. The inquiry is one usually inapplicable to the latter sex, which accounts for the small number answering. It will be noticed, also, that the average is about one person more for the males than for the females. In regard to dependence, there seems to be a slight difference in favor of those counties which have the most distinctly urban population, and in which manufact-

Hours Employed—Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . .	177	85	48	977	11.50
Berkshire, . . .	168	144	86	1,495	10.38
Bristol, . . .	335	292	87	3,083	10.56
Dukes, . . .	45	27	60	267	9.89
Essex, . . .	616	566	92	5,876	10.38
Franklin, . . .	132	111	84	961	8.66
Hampden, . . .	611	545	89	5,752	10.55
Hampshire, . .	106	82	77	937	11.45
Middlesex, . .	1,957	1,806	92	18,359	10.16
Nantucket, . . .	17	17	100	136	8.00
Norfolk, . . .	423	364	86	3,619	9.94
Plymouth, . . .	317	260	82	2,693	10.37
Suffolk, . . .	1,616	1,424	88	15,022	10.55
Worcester, . . .	1,228	1,063	87	11,433	10.75
For the State, .	7,748	6,786	88	70,610	10.41

ures supply the chief means of support. In Suffolk, Worcester, Plymouth, Middlesex and Hampden, the average is low. In Berkshire and Hampshire, it is high. Yet, in Bristol, with a large population in cities, the average is high, and in Barnstable, low.

"Number of hours per day employed in your occupation," was the form of inquiry made. The per cent of females answering this question appears to be larger than of males. This is owing, probably, to the fact that a large proportion of the former are employed in school teaching, an employment in which the hours of labor are regulated by laws and ordinances; and being thus made exact, the question is more sus-

Hours Employed—Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable, . .	52	50	96	321	6.42
Berkshire, . . .	58	58	100	339	5.84
Bristol, . . .	64	60	94	407	6.78
Dukes, . . .	10	8	80	48	6.00
Essex, . . .	204	196	96	1,211	6.18
Franklin, . . .	50	50	100	303	6.06
Hampden, . . .	127	127	100	803	6.32
Hampshire, . .	61	60	98	385	6.42
Middlesex, . . .	398	393	99	2,302	5.86
Nantucket, . .	3	3	100	18	6.00
Norfolk, . . .	131	122	93	749	6.14
Plymouth, . . .	70	66	94	457	6.92
Suffolk, . . .	231	214	93	1,609	7.52
Worcester, . . .	347	337	97	2,113	6.27
For the State, .	1,806	1,744	97	11,065	6.34

ceptible of answer, than in the cases of many avocations pursued by men. For instance, a clergyman or a travelling salesman can hardly reply with any definiteness to this question; hence many have made no reply. The fact that so large a proportion of the female returns were from public school teachers who are employed but five or six hours per day, also accounts for the great difference in the average hours of labor performed.

It is noticeable, that the counties in which that average is the largest, are the same for both sexes; viz., Barnstable, Bristol, Hampden, Hampshire and Suffolk. Plymouth, however, shows a large average for females.

Days Employed—Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . .	177	157	89	44,071	280.71
Berkshire, . .	168	133	79	38,341	288.28
Bristol, . . .	335	282	84	82,959	294.18
Dukes, . . .	45	29	64	8,131	280.38
Essex, . . .	616	529	86	152,485	288.25
Franklin, . .	132	120	91	35,765	298.04
Hampden, . .	611	526	86	156,221	296.99
Hampshire, . .	106	82	77	24,244	295.66
Middlesex, . .	1,957	1,635	84	480,425	293.84
Nantucket, . .	17	16	94	4,390	274.38
Norfolk, . . .	423	388	92	97,228	250.59
Plymouth, . .	317	250	79	71,886	287.54
Suffolk, . . .	1,616	1,367	85	405,479	296.62
Worcester, . .	1,228	1,024	83	296,320	289.37
For the State, .	7,748	6,538	84	1,897,945	290.29

The number of days employed during the year is much less for females than for males, and the reason for it is probably the same as that given in respect to the hours per day employed. Clergymen have generally responded that they worked 365 days during the year, while public school teachers, who are mostly females, are engaged in their business, in cities, but about 200 days, and in country towns, no more than one-half as long.

It is a little remarkable that the average for females, in Suffolk County, should be so much in excess of any of the other county averages.

Days Employed—Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable, . .	52	52	100	7,683	147.75
Berkshire, . .	58	57	98	8,112	142.32
Bristol, . . .	64	62	97	11,974	193.13
Dukes, . . .	10	9	90	923	102.56
Essex, . . .	204	174	85	36,821	211.61
Franklin, . .	50	47	94	6,654	141.57
Hampden, . .	127	124	98	21,626	174.40
Hampshire, . .	61	59	97	8,748	148.27
Middlesex, . .	398	361	91	75,285	208.55
Nantucket, . .	3	3	100	487	162.33
Norfolk, . . .	131	117	89	21,572	184.38
Plymouth, . .	70	63	90	11,256	178.67
Suffolk, . . .	231	190	82	48,899	257.36
Worcester, . .	347	323	93	55,636	172.25
For the State, .	1,806	1,641	91	315,676	192.37

The average number of days employed for all female salaried persons in the State who returned schedules, is 192.37, or less than 62 per cent of the working days in a year.

Keeping in mind what we have just said respecting those who teach, it will be seen that those engaged in other occupations, such as salesmen, book-keepers, etc., whose employments are carried on during all the working days of the year, cannot, in a very large proportion of cases, have steady engagements.

Daily Wages—Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . .	177	110	62	$296 13	$2 69
Berkshire, . .	168	114	68	358 50	3 14
Bristol, . . .	335	249	74	707 33	2 84
Dukes, . . .	45	22	49	49 01	2 23
Essex, . . .	616	453	74	1,317 00	2 91
Franklin, . .	132	95	72	248 99	2 63
Hampden, . .	611	358	59	1,260 99	3 52
Hampshire, . .	106	58	55	142 84	2 46
Middlesex, . .	1,957	1,411	72	4,481 86	3 18
Nantucket, . .	17	10	59	26 60	2 66
Norfolk, . . .	423	289	68	940 36	3 25
Plymouth, . .	317	220	69	694 73	3 15
Suffolk, . . .	1,616	1,237	77	3,912 17	3 16
Worcester, .	1,228	848	69	2,483 23	2 93
For the State, .	7,748	5,474	71	16,919 74	3 09

The average daily wages of male salaried persons is shown to be $3.09, and of female salaried persons, $1.94. Probably these sums are much below the amount that would have been fixed upon by any one having no data to assist the judgment. But the large proportion of salesmen and clerks who work for two, three or four hundred dollars per year, has the effect of thus reducing the average.

Hampden County furnishes the highest average, and, strange to say, Hampshire, which adjoins it, furnishes the lowest, with one exception, for males, and the lowest, with three exceptions, for females.

Daily Wages—Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable, . .	52	50	96	$77 37	$1 55
Berkshire, . .	58	40	69	58 05	1 45
Bristol, . . .	64	60	94	116 00	1 93
Dukes, . . .	10	6	60	8 35	1 39
Essex, . . .	204	154	75	294 60	1 91
Franklin, . .	50	44	88	60 24	1 37
Hampden, . .	127	92	72	204 40	2 22
Hampshire, . .	61	54	89	82 24	1 52
Middlesex, . .	398	329	83	702 41	2 13
Nantucket, . .	3	3	100	3 86	1 29
Norfolk, . . .	131	107	82	205 51	1 92
Plymouth, . .	70	49	70	85 51	1 75
Suffolk, . . .	231	169	73	349 20	2 07
Worcester, . .	347	307	88	590 55	1 92
For the State, .	1,806	1,464	81	2,838 29	1 94

In regard to these exceptions, a sufficiently large number did not answer in Dukes and Nantucket to make a valuable average, being only six females in the former and three in the latter.

After Hampden, Middlesex County pays the highest salaries to both male and female, and is followed by Suffolk with a rate nearly as high.

Yearly Wages—Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable,	177	173	98	$137,030 00	$792 08
Berkshire,	168	155	92	155,046 00	1,000 30
Bristol,	335	323	96	312,201 00	966 57
Dukes,	45	44	98	30,341 00	689 57
Essex,	616	581	94	565,575 00	973 45
Franklin,	132	128	97	111,157 00	868 41
Hampden,	611	591	97	660,559 00	1,117 70
Hampshire,	106	100	94	102,599 00	1,025 99
Middlesex,	1,957	1,851	95	1,923,075 00	1,038 94
Nantucket,	17	17	100	13,617 00	801 00
Norfolk,	423	409	97	429,674 00	1,050 55
Plymouth,	317	298	94	269,722 00	905 11
Suffolk,	1,616	1,516	94	1,598,268 00	1,054 27
Worcester,	1,228	1,128	92	1,123,355 00	995 88
For the State,	7,748	7,314	94	7,432,219 00	1,016 16

This question read in the schedule, "Amount of wages derived from your occupation during the year."

In the examination of these tables and those preceding relating to daily wages and to the number of days employed, a brief explanation is necessary in regard to one point, that no one may be led astray. It may seem that the "average for each person answering," in the above tables, for any particular county, can be divided by the "average for each person answering" in the tables of daily wages, and produce the "average for each person answering" in the tables of days employed, or by the average of days employed, and produce the daily wages. This could not be done even had the same

Yearly Wages—Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable, . .	52	52	100	$11,600 00	$223 08
Berkshire, . .	58	58	100	12,819 00	221 02
Bristol, . . .	64	64	100	23,723 00	370 67
Dukes, . . .	10	10	100	1,192 00	119 20
Essex, . . .	204	199	98	84,028 00	422 25
Franklin, . .	50	49	98	11,647 00	237 69
Hampden, . .	127	126	99	55,160 00	437 78
Hampshire, . .	61	61	100	13,897 00	227 82
Middlesex, . .	398	393	99	178,987 00	455 44
Nantucket, . .	3	3	100	597 00	199 00
Norfolk, . . .	131	129	98	49,115 00	380 74
Plymouth, . .	70	67	96	23,110 00	344 93
Suffolk, . . .	231	225	97	128,813 00	572 50
Worcester, . .	347	242	70	125,777 00	519 74
For the State, .	1,806	1,678	93	720,465 00	429 36

persons answered each question. But the persons who replied as to days employed are not identical with those who replied as to daily wages and yearly wages. So it is plainly seen that no relation can possibly exist between the averages of these three tables.

Other Earnings—Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . .	177	50	28	$8,365 00	$167 30
Berkshire, . .	168	39	23	7,280 00	186 67
Bristol, . . .	335	59	18	13,853 00	234 80
Dukes, . . .	45	20	44	4,285 00	214 25
Essex, . . .	616	122	20	26,294 00	215 52
Franklin, . .	132	26	20	3,367 00	129 50
Hampden, . .	611	116	19	23,892 00	205 97
Hampshire, . .	106	25	24	5,190 00	207 60
Middlesex, . .	1,957	272	14	57,980 00	213 16
Nantucket, . .	17	7	41	655 00	93 57
Norfolk, . . .	423	93	22	16,087 00	172 98
Plymouth, . .	317	57	18	11,838 00	207 68
Suffolk, . . .	1,616	165	10	43,729 00	265 02
Worcester, . .	1,228	253	21	57,716 00	228 13
For the State, .	7,748	1,304	17	280,531 00	215 13

The tables on this and the following page exhibit the results obtained from the inquiry, "Amount of your other earnings." By this question, it was intended to discover the amounts earned by individuals outside their regular occupations. The average for males, throughout the State, is shown to be $215.13, and for females, $94.97.

These are sums of considerable consequence, and increase vitally the annual revenue to be expended in the support of life. The annual income for males is thus enlarged to $1,231.29, and for females, to $524.33.

The amounts of "other earnings" returned represent, in many cases, undoubtedly, much severer labor for each dollar

Other Earnings—Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable, . .	52	11	21	$365 00	$33 18
Berkshire, . .	58	6	10	205 00	34 17
Bristol, . . .	64	10	16	341 00	34 10
Dukes, . . .	10	5	50	215 00	43 00
Essex, . . .	204	18	9	1,181 00	65 61
Franklin, . .	50	5	10	143 00	28 60
Hampden, . .	127	10	8	1,619 00	161 90
Hampshire, . .	61	9	15	223 00	24 78
Middlesex, . .	398	33	8	4,800 00	145 45
Nantucket, . .	3	1	33	25 00	25 00
Norfolk, . . .	131	6	5	286 00	47 67
Plymouth, . .	70	6	9	745 00	124 17
Suffolk, . . .	231	10	4	1,938 00	193 80
Worcester, . .	347	63	18	6,244 00	99 11
For the State, .	1,806	193	11	18,330 00	94 97

produced than do the amounts of "yearly wages" returned. They are the hardly earned dollars toiled for by evening lamps, when the system is already exhausted by a regular day's work.

Fifty-four per cent more males than females have answered this question. Suffolk County seems to have furnished the smallest per cent of answers for both sexes. And, throwing out Dukes and Nantucket, in which the replies were too few to be of much value in arriving at a percentage, Barnstable furnished the largest. In other words, the county most essentially urban possesses the smallest per cent of persons who add to their regular income by extraordinary earnings;

Children's Earnings Returned by Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . . .	177	17	10	$2,694 00	$158 47
Berkshire, . . .	168	6	4	1,045 00	174 17
Bristol, . . .	335	17	5	6,005 00	353 23
Dukes, . . .	45	1	2	15 00	15 00
Essex, . . .	616	24	4	5,467 00	227 79
Franklin, . . .	132	6	5	785 00	130 83
Hampden, . . .	611	20	3	3,703 00	185 15
Hampshire, . .	106	9	8	1,598 00	177 55
Middlesex, . . .	1,957	53	3	12,634 00	238 38
Nantucket, . .	17	-	-	-	-
Norfolk, . . .	423	14	3	2,616 00	186 93
Plymouth, . . .	317	14	4	1,847 00	131 93
Suffolk, . . .	1,616	36	2	6,107 00	169 64
Worcester, . . .	1,228	38	3	6,840 00	180 00
For the State, .	7,748	255	3	51,356 00	201 39

while the one most essentially rural possesses the largest. Yet the average amount for each is among the smallest for the latter, and the very largest for the former.

"Amount of minor children's earnings," was intended to secure a return of the sums earned by those children under legal age, living in the family, and contributing by their labor to the income of the family. Naturally, it was a question that would be answered by but few women, and it will be seen by the table that in but three counties, and by only four women, were replies made. The average ($315.50) derived from the replies of so few persons is manifestly of small value in furnishing a basis for speculation.

Children's Earnings Returned by Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable,	52	1	2	$50 00	$50 00
Berkshire,	58	-	-	-	-
Bristol,	64	-	-	-	-
Dukes,	10	-	-	-	-
Essex,	204	-	-	-	-
Franklin,	50	-	-	-	-
Hampden,	127	1	8	62 00	62 00
Hampshire,	61	-	-	-	-
Middlesex,	398	-	-	-	-
Nantucket,	8	-	-	-	-
Norfolk,	131	-	-	-	-
Plymouth,	70	-	-	-	-
Suffolk,	231	2	9	1,150 00	575 00
Worcester,	347	-	-	-	-
For the State,	1,806	4	2	1,262 00	315 50

The 255 males who answered were sufficient in number to afford an average that is of real value in determining the worth of the assistance of children in the support of families.

The combined yearly wages, other earnings and children's earnings of males having salaries, is thus shown to be $1,432.68.

A few pages forward is shown the wife's earnings, a fourth means of increase of the family income. It is to be borne in mind, however, that but a small number of males returning schedules have *all* these sources of revenue.

In connection with this subject of children's earnings, especial attention is called to Part IV., Chap. IV. (page 354),

Unable to Work—Returned by Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable,	177	3	2	3	1.00
Berkshire,	168	3	2	3	1.00
Bristol,	335	2	-	2	1.00
Dukes,	45	2	4	4	2.00
Essex,	616	11	2	11	1.00
Franklin,	132	3	2	3	1.00
Hampden,	611	9	1	10	1.11
Hampshire,	106	2	2	2	1.00
Middlesex,	1,957	33	2	37	1.12
Nantucket,	17	1	6	1	1.00
Norfolk,	423	6	1	7	1.17
Plymouth,	317	6	2	6	1.00
Suffolk,	1,616	18	1	21	1.17
Worcester,	1,228	32	3	38	1.19
For the State,	7,748	131	2	148	1.13

of the report of this Bureau last year, where will be found much minute and corroborative information upon the same subject.

This question appeared in the schedule as, "Number of persons in the family, over eighteen years of age, prevented by continuous sickness or physical disability from attending to any occupation."

The result shows that there is less than two per cent of infirm dependence among males, or that for every fifty-two persons who returned schedules, there was one person unable to work.

Unable to Work—Returned by Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable, ...	52	-	-	-	-
Berkshire, ...	58	-	-	-	-
Bristol, ...	64	-	-	-	-
Dukes, ...	10	-	-	-	-
Essex, ...	204	2	1	2	1.00
Franklin, ...	50	1	2	1	1.00
Hampden, ...	127	-	-	-	-
Hampshire, ...	61	-	-	-	-
Middlesex, ...	398	2	-	3	1.50
Nantucket, ...	3	-	-	-	-
Norfolk, ...	131	-	-	-	-
Plymouth, ...	70	1	1	1	1.00
Suffolk, ...	231	2	1	2	1.00
Worcester, ...	347	1	-	1	1.00
For the State, . .	1,806	9	-	10	1.11

Among females, there was only one person unable to work to every 180 returning schedules.

Persons Owning Houses—Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable,	177	67	38	67	1.00
Berkshire,	168	33	20	33	1.00
Bristol,	335	54	16	54	1.00
Dukes,	45	19	42	19	1.00
Essex,	616	143	23	143	1.00
Franklin,	132	30	23	30	1.00
Hampden,	611	121	20	121	1.00
Hampshire,	106	21	20	21	1.00
Middlesex,	1,957	464	24	464	1.00
Nantucket,	17	6	35	6	1.00
Norfolk,	423	108	26	108	1.00
Plymouth,	317	89	28	89	1.00
Suffolk,	1,616	197	12	197	1.00
Worcester,	1,228	214	17	214	1.00
For the State,	7,748	1,566	20	1,566	1.00

The highest per cent of persons owning houses is found in the counties of Barnstable, Dukes and Nantucket; and the lowest in Bristol, Suffolk and Worcester. Referring to page 32, it will be seen that the same counties make a similar exhibit for the wage class. The rural counties, generally, seem to have the largest house-owning population. Berkshire, considering that its people are chiefly agricultural, has a small per cent of persons who own the houses in which they live. The State average is barely maintained in this county. Among the wage class (page 32), this fact appears still more prominently, the county average being below the State.

Persons Owning Houses—Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable,	52	1	2	1	1.00
Berkshire,	58	1	2	1	1.00
Bristol,	64	1	2	1	1.00
Dukes,	10	-	-	-	-
Essex,	204	8	4	8	1.00
Franklin,	50	-	-	-	-
Hampden,	127	1	-	1	1.00
Hampshire,	61	1	2	1	1.00
Middlesex,	398	10	3	10	1.00
Nantucket,	3	-	-	-	-
Norfolk,	131	3	2	3	1.00
Plymouth,	70	2	3	2	1.00
Suffolk,	231	3	1	3	1.00
Worcester,	347	4	1	4	1.00
For the State,	1,806	35	2	35	1.00

The remarks here made refer to the males, the number of females answering this inquiry being too few to make the percentages valuable.

The possession of a house is one of the most important acquisitions made by man; hence the results obtained by this question are of considerable value in an examination into the condition of any portion of the laboring people of a State.

The combination of the returns of those owning houses with those who hire, does not, of course, equal all who have returned schedules, as there are many who are simply boarders, and neither own nor rent a house. There is every reason to believe that these two questions (*persons owning houses,*

Amount of Mortgage—Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . .	177	14	8	$9,610 00	$686 43
Berkshire, . .	168	12	7	23,900 00	1,991 67
Bristol, . . .	335	13	4	37,710 00	2,900 77
Dukes, . . .	45	3	7	3,325 00	1,108 33
Essex, . . .	616	57	9	108,695 00	1,906 93
Franklin, . .	132	17	13	12,400 00	729 41
Hampden, . .	611	64	10	175,955 00	2,749 30
Hampshire, . .	106	13	12	33,900 00	2,607 70
Middlesex, . .	1,957	254	13	585,657 00	2,305 74
Nantucket, . .	17	-	-	-	-
Norfolk, . . .	423	56	13	131,545 00	2,349 02
Plymouth, . .	317	27	9	34,480 00	1,277 04
Suffolk, . . .	1,616	112	7	378,300 00	3,377 68
Worcester, . .	1,228	113	9	316,322 00	2,799 31
For the State, .	7,748	755	10	1,851,799 00	2,452 71

and *number of rooms hired*) have been very fully answered in cases where they were applicable.

The question as to ownership of house was followed immediately by the question, "If you own it, what is the amount of mortgage on it?"

The average amount of each mortgage, for males, is $2,452.71, and for females, $1,869.74. The latter average is of less value, as it is based on only 19 returns.

It will be seen that the amount varies greatly in the different counties.

In Barnstable, it is but $686.43, while in Suffolk, it is $3,377.68. In Franklin and Plymouth, it is also low, as

Amount of Mortgage—Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable, . .	52	1	2	$350 00	$350 00
Berkshire, . .	58	1	2	500 00	500 00
Bristol, . . .	64	-	-	-	-
Dukes, . . .	10	-	-	-	-
Essex, . . .	204	3	1	2,350 00	783 33
Franklin, . .	50	-	-	-	-
Hampden, . .	127	-	-	-	-
Hampshire, . .	61	-	-	-	-
Middlesex, . .	398	9	2	13,225 00	1,469 44
Nantucket, . .	3	-	-	-	-
Norfolk, . . .	131	-	-	-	-
Plymouth, . .	70	-	-	-	-
Suffolk, . . .	231	3	1	17,500 00	5,833 33
Worcester, . .	347	2	-	1,600 00	800 00
For the State, .	1,806	19	1	35,525 00	1,869 74

compared with the general average for the State. In Dukes, the returns were so few as to make the result of less value. In Nantucket, it will be noticed by the preceding tables, that there were six persons owning houses, and by the above it is seen that there were no mortgages.

By the preceding pages, it is seen that 1,566 males and 35 females own houses,—an aggregate of 1,601 persons; by the above, there are found to be 755 males and 19 females who live in mortgaged houses,—an aggregate of 774; or a little over 48 per cent of those owning houses. Among wage laborers (page 34), 44½ per cent of the houses were found to be thus encumbered.

Rate of Interest—Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable,	177	14	8	109.7	7.8
Berkshire,	168	9	5	63.5	7.0
Bristol,	335	13	4	96.3	7.4
Dukes,	45	3	7	19.0	6.3
Essex,	616	57	9	419.5	7.4
Franklin,	132	17	13	120.5	7.1
Hampden,	611	64	10	461.3	7.2
Hampshire,	106	13	12	92.8	7.1
Middlesex,	1,957	250	13	1,883.6	7.5
Nantucket,	17	-	-	-	-
Norfolk,	423	56	13	427.7	7.6
Plymouth,	317	26	8	191.6	7.4
Suffolk,	1,616	108	7	809.1	7.5
Worcester,	1,228	112	9	780.5	6.9
For the State,	7,748	742	10	5,475.1	7.4

The rate of interest paid on mortgages in the different sections of the State, as shown by the above tables, makes an interesting exhibit.

Berkshire, Franklin, Hampden, Hampshire and Worcester show a rate per cent less than the average for the State, being the only counties in which it was below, except Dukes, from which only three replies to the question were received; not enough on which to base a proper average.

The highest rate per cent is in Barnstable. After which come Norfolk, Middlesex and Suffolk. These are all that are above the State average.

Rate of Interest—Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable, . .	52	1	2	7.0	7.0
Berkshire, . . .	58	1	2	8.0	8.0
Bristol, . . .	64	-	-	-	-
Dukes, . . .	10	-	-	-	-
Essex, . . .	204	3	1	21.8	7.3
Franklin, . . .	50	-	-	-	-
Hampden, . . .	127	-	-	-	-
Hampshire, . .	61	-	-	-	-
Middlesex, . .	393	9	2	68.5	7.6
Nantucket, . .	3	-	-	-	-
Norfolk, . . .	131	-	-	-	-
Plymouth, . . .	70	-	-	-	-
Suffolk, . . .	231	3	1	21.0	7.0
Worcester, . . .	347	1	-	7.0	7.0
For the State, .	1,806	18	1	133.3	7.4

Number of Rooms hired by Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable,	177	43	24	254	5.91
Berkshire,	168	61	36	463	7.59
Bristol,	335	136	41	919	6.76
Dukes,	45	10	22	71	7.10
Essex,	616	247	40	1,714	6.94
Franklin,	132	53	40	359	6.77
Hampden,	611	276	45	1,738	6.30
Hampshire,	106	37	35	235	6.35
Middlesex,	1,957	749	38	4,826	6.43
Nantucket,	17	5	29	24	4.80
Norfolk,	423	168	40	1,173	6.98
Plymouth,	317	111	35	703	6.33
Suffolk,	1,616	710	44	3,922	5.52
Worcester,	1,228	596	49	3,627	6.09
For the State,	7,748	3,202	41	20,028	6.25

Three thousand two hundred and two males answer that they hire houses, aggregating 20,028 rooms; an average of 6.25 rooms to each. Among females, 122 answer that they hire 498 rooms; an average of 4.08 rooms to each.

In Berkshire County, the number of rooms to the family is more than in any other, being 7.59 to each, for males answering, and 6.50 to each, for females answering. Suffolk, Worcester and Barnstable afford the least number of rooms to each male answering. This is what we might have expected in regard to Suffolk and Worcester, as they contain large masses of people living within concentrated limits who are obliged to content themselves with restricted accommodations.

Number of Rooms hired by Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable, ...	52	–	–	–	–
Berkshire, . . .	58	2	3	13	6.50
Bristol, ...	64	3	5	19	6.33
Dukes, ...	10	–	–	–	–
Essex, ...	204	11	5	50	4.55
Franklin, . . .	50	–	–	–	–
Hampden, . . .	127	13	10	47	3.60
Hampshire, . . .	61	–	–	–	–
Middlesex, . . .	398	21	5	98	4.67
Nantucket, . . .	3	–	–	–	–
Norfolk, . . .	131	4	3	9	2.25
Plymouth, . . .	70	1	1	1	1.00
Suffolk, ...	231	40	17	133	3.33
Worcester, . . .	347	27	8	128	4.74
For the State, . .	1,806	122	7	498	4.08

But in Barnstable it would have been natural to expect to find a different condition of affairs. The explanation may lie in the different occupations pursued in a maritime county like Barnstable, many schedules in the latter county being received from master mariners and those connected with seafaring employments, whose families, owing to the absence of the husband, would be likely to require a smaller tenement than others. It will be noticed that the average for Plymouth County is low, as compared with the interior portions of the State.

Rent Paid by Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . .	177	48	27	$3,232 00	$67 33
Berkshire, . .	168	61	36	10,088 00	165 37
Bristol, . . .	835	136	41	26,401 00	194 12
Dukes, . . .	45	11	24	845 00	76 82
Essex, . . .	616	253	41	45,029 00	177 98
Franklin, . .	132	54	41	8,036 00	148 81
Hampden, . .	611	279	46	56,710 00	203 26
Hampshire, . .	106	42	40	6,870 00	163 57
Middlesex, . .	1,957	744	38	163,645 00	219 95
Nantucket, . .	17	5	29	175 00	35 00
Norfolk, . . .	423	166	39	29,924 00	180 26
Plymouth, . .	317	111	35	16,013 00	144 26
Suffolk, . . .	1,616	723	45	212,889 00	294 45
Worcester, . .	1,228	460	37	107,979 00	234 74
For the State, .	7,748	3,093	40	687,836 00	222 38

In respect to the amount paid for rent in different localities, the tables above furnish much instruction. The cost for shelter varies widely, much more widely than it would be natural to expect, considering that there is no such extraordinary difference in the county statements of yearly earnings. In Barnstable, the rent paid per year is only $67.33; in Berkshire, it is $165.37; in Franklin, $148.81; in Hampshire, $163.57. While in Suffolk, it is $294.45; in Worcester, $234.74, and in Middlesex, $219.95. The average for the State, for males, is seen to be $222.38.

Rent Paid by Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable, . .	52	1	2	$156 00	$156 00
Berkshire, . .	58	2	3	218 00	109 00
Bristol, . . .	64	4	6	744 00	186 00
Dukes, . . .	10	-	-	-	-
Essex, . . .	204	11	5	1,234 00	112 18
Franklin, . .	50	-	-	-	-
Hampden, . .	127	13	10	1,212 00	93 23
Hampshire, . .	61	-	-	-	-
Middlesex, . .	398	18	5	3,255 00	180 83
Nantucket, . .	3	-	-	-	-
Norfolk, . . .	131	4	3	401 00	100 25
Plymouth, . .	70	-	-	-	-
Suffolk, . . .	231	38	16	7,287 00	191 76
Worcester, . .	347	27	8	3,757 00	139 15
For the State, .	1,806	118	7	18,264 00	154 78

The returns from females are not sufficiently numerous to make the averages obtained especially valuable.

Much the largest per cent of women, hiring rooms and paying rent, is seen to be in Suffolk County.

Value of Garden Crops—Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . .	177	31	18	$510 00	$16 45
Berkshire, . . .	168	37	22	831 00	22 46
Bristol, . . .	335	28	8	564 00	20 14
Dukes, . . .	45	16	36	255 00	15 94
Essex, . . .	616	64	10	2,329 00	36 39
Franklin, . . .	132	40	30	1,070 00	26·75
Hampden, . . .	611	87	14	1,236 00	14 21
Hampshire, . .	106	17	16	191 00	11 24
Middlesex, . .	1,957	117	6	2,398 00	20 49
Nantucket, . .	17	4	24	58 00	14 50
Norfolk, . . .	423	48	11	1,226 00	25 54
Plymouth, . . .	317	42	13	1,243 00	29 59
Suffolk, . . .	1,616	18	1	362 00	20 11
Worcester, . . .	1,228	26	2	2,174 00	83 61
For the State, .	7,748	575	7	14,447 00	25 13

This question appeared on the schedules as, "Value of garden crops raised by you, and used in your family, less all money expenditures on account of the same."

The general object of the schedule, it may be seen, was to discover the various sources of income of families, the amounts derived from each source, and the ways of expenditure. As a means of increase to the family revenue, it was believed that the kitchen garden would be found to contribute something considerable. The result justifies our expectations. It is seen that 575 males, out of 7,748, answered this question, equal to 7 per cent,—returning an aggregate value of $14,447, or an average of $25.13 to each. It is probable that a considerably

Value of Garden Crops—Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable, . .	52	1	2	$5 00	$5 00
Berkshire, . . .	58	2	3	37 00	18 50
Bristol, . . .	64	-	-	-	-
Dukes, . . .	10	1	10	3 00	3 00
Essex, . . .	204	4	2	360 00	90 00
Franklin, . . .	50	-	-	-	-
Hampden, . . .	127	1	-	4 00	4 00
Hampshire, . .	61	-	-	-	-
Middlesex, . .	398	1	-	70 00	70 00
Nantucket, . .	3	-	-	-	-
Norfolk, . . .	131	-	-	-	-
Plymouth, . . .	70	-	-	-	-
Suffolk, . . .	231	-	-	-	-
Worcester, . .	347	3	1	25 00	8 33
For the State, .	1,806	13	-	504 00	38 77

larger number than have answered are possessed of gardens; as the question is one rather difficult of answer in some cases, and it is likely that many, for that reason, have made no reply. Many persons would consider it an impossibility to fix upon any exact sum as the value of the garden, above what was expended upon it. All such would be likely to leave the question unanswered, and thereby convey the impression that they had no such source of income. Others, not a few, who derive substantial value from a garden, look upon it as a nuisance and a way of expense, rather than of revenue, and hence have made no reply. So that seven per cent does not, probably, represent nearly all the persons having gardens.

Cost of Living of Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . .	177	151	85	$97,154 00	$643 40
Berkshire, . . .	168	134	80	126,601 00	944 78
Bristol, . . .	335	272	81	238,644 00	877 37
Dukes, . . .	45	42	93	16,590 00	395 00
Essex, . . .	616	441	72	370,480 00	840 09
Franklin, . . .	132	102	77	77,560 00	760 39
Hampden, . . .	611	512	84	505,145 00	986 61
Hampshire, . .	106	74	70	75,995 00	1,026 96
Middlesex, . .	1,957	1,490	76	1,411,355 00	947 21
Nantucket, . .	17	10	59	8,175 00	817 50
Norfolk, . . .	423	319	75	304,524 00	954 62
Plymouth, . . .	317	238	75	184,887 00	776 83
Suffolk, . . .	1,616	1,141	71	1,123,510 00	984 67
Worcester, . . .	1,228	929	76	807,042 00	868 72
For the State, .	7,748	5,855	76	5,347,662 00	913 35

The average cost of living, for males returning schedules, is seen to be $913.35; and for females, $358.72.

By reference to pages 44 and 45, it will be seen that the corresponding averages for wage laborers are $488.96 and $182.86. It was seen (pages 214 and 215) that the yearly earnings of salaried persons were, for males, $1,016.16; for females, $429.36; while the yearly earnings of wage laborers were found to be (pages 24 and 25), for males, $482.72; for females, $198.76. Thus, considering only males, the earnings of salaried people are seen to be 11 per cent more than their cost of living; while, among wage laborers, the earnings are slightly less than the cost of living.

C

COUNTIES.
Barnstable, . .
Berkshire, . . .
Bristol, . . .
Dukes, . . .
Essex, . . .
Franklin, . . .
Hampden, . . .
Hampshire, . .
Middlesex, . .
Nantucket, . .
Norfolk, . . .
Plymouth, . . .
Suffolk, . . .
Worcester, . . .
For the State, .

Number of Volumes in Library—Males.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable, . .	177	30	17	9,821	327.37
Berkshire, . . .	168	41	24	17,329	422.66
Bristol, . . .	335	62	19	30,927	498.82
Dukes, . . .	45	14	31	3,125	223.21
Essex, . . .	616	131	21	52,548	401.13
Franklin, . . .	132	38	29	15,323	403.24
Hampden, . . .	611	136	22	53,030	389.92
Hampshire, . .	106	39	37	19,149	491.00
Middlesex, . .	1,957	334	17	121,054	362.44
Nantucket, . .	17	4	24	981	245.25
Norfolk, . . .	423	101	24	76,598	758.39
Plymouth, . . .	317	65	21	26,511	407.86
Suffolk, . . .	1,616	161	10	47,854	297.23
Worcester, . .	1,228	265	22	94,424	356.32
For the State, .	7,748	1,421	18	568,674	400.19

The returns of "volumes in libraries" includes only those libraries containing one hundred volumes or over. All numbers less than this have been disregarded in tabulating. The average for the State, among males, is 400.19. The returns from Norfolk County, in which 101 males answered, out of 423 returning schedules, show an aggregate of 76,598 volumes, or an average of 758.39 to each library. Whether this is to be considered as showing an extraordinary literary activity in that county, which does not exist in other sections of the State, is for the reader to determine. We present the facts, the accuracy of which cannot be questioned, and leave to others the explanation. The returns from some towns, in

Number of Volumes in Library—Females.

COUNTIES.	No. of Schedules received.	No. of Females answering.	Per cent answering.	Aggregate for all Females answering.	Average for each Female answering.
Barnstable,	52	1	2	350	350.00
Berkshire,	58	3	5	450	150.00
Bristol,	64	1	2	200	200.00
Dukes,	10	1	10	200	200.00
Essex,	204	10	5	1,747	174.70
Franklin,	50	1	2	200	200.00
Hampden,	127	4	3	626	156.50
Hampshire,	61	-	-	-	-
Middlesex,	398	13	3	2,750	211.54
Nantucket,	3	-	-	-	-
Norfolk,	131	1	-	105	105.00
Plymouth,	70	6	9	869	144.83
Suffolk,	231	11	5	2,555	232.27
Worcester,	347	6	2	1,280	213.33
For the State,	1,806	58	3	11,332	195.38

regard to this question, were simply astonishing. There were exceptional instances of towns, where from seventy-five to eighty per cent of the salaried persons returning schedules, possessed libraries averaging considerably over one thousand volumes each. Suffolk County, where the public reading facilities are almost unlimited, as was to be expected, returned the smallest number of volumes *per capita* of any of the large counties. This was the case for males. The result differs somewhat for females; but it is always to be borne in mind that the small number of answers from persons of this sex makes the averages of much less value.

Wife's Earnings.

COUNTIES.	No. of Schedules received.	No. of Males answering.	Per cent answering.	Aggregate for all Males answering.	Average for each Male answering.
Barnstable,	177	6	3	$215 00	$35 83
Berkshire,	168	4	2	542 00	135 50
Bristol,	335	10	3	2,055 00	205 50
Dukes,	45	1	2	75 00	75 00
Essex,	616	18	3	5,361 00	297 83
Franklin,	132	2	2	170 00	85 00
Hampden,	611	41	7	6,204 00	151 32
Hampshire,	106	2	2	150 00	75 00
Middlesex,	1,957	59	3	10,631 00	180 19
Nantucket,	17	2	12	130 00	65 00
Norfolk,	423	24	6	2,952 00	123 00
Plymouth,	317	16	5	2,983 00	186 44
Suffolk,	1,616	32	2	7,243 00	226 34
Worcester,	1,228	55	4	8,059 00	146 53
For the State,	7,748	272	4	46,770 00	171 95

Four per cent of the salaried persons returning schedules answered as to the "amount of wife's earnings for the year ending May 1, 1875." Two hundred and seventy-two wives, of 7,748 men, earned $46,770; giving an average of $171.95 as the earnings of each wife. This is another item to be considered in the examination of the various sources of income which contribute to the support of families. It is to be considered also in the light of its effect on the social and domestic well-being of communities. For it is a question of moment to future generations and even to the present, whether the value of the wages thus brought in is not more than offset by the

physical injury to wives and mothers, and the moral injury to families in the neglected training of children.

CHAPTER II.

PRESENTATION BY COUNTIES, AND EXHIBIT OF AVERAGES.

The tables of this chapter exhibit a presentation by schedule questions for each of the fourteen counties in the State, and for the State as a whole. The entire number of schedules received is shown, and the number from each sex, the number answering each question, by sexes, the per cent answering in the same way, and the average for each person answering, also by sexes.

The tables of averages following are of great importance, as they present, in a condensed form, the real result of the whole work. They are deduced from returns received from *salaried* persons. In Part I. (pages 66 to 69 inclusive) will be found similar tables having reference to the returns from *wage* laborers.

With these few words of introduction, we proceed to the tabulations.

Presentation by Counties.

[Note.—For a similar presentation respecting *wage* laborers, see Part I., page 50, *et seq.* The facts presented in these tables refer to *salaried* persons.]

Barnstable County.

Whole Number of Schedules Received,—Males, 177; Females, 52.

Schedule Questions.	Number Answering.		Per cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	130	2	73	4	2.63	1.50
Hours employed, .	85	50	48	96	11.50	6.42
Days employed, .	157	52	89	100	280.71	147.75
Daily wages, . .	110	50	62	96	$2.69	$1.55
Yearly wages, .	173	52	98	100	$792.08	$223.08
Other earnings, .	50	11	28	21	$167.30	$33.18
Wife's earnings, .	6	-	3	-	$35.83	-
Children's earnings,	17	1	10	2	$158.47	$50.00
Unable to work, .	3	-	2	-	1.00	-
Who own houses, .	67	1	38	2	1.00	1.00
Amount of mortgage, . . .	14	1	8	2	$686.43	$350.00
Rate of interest, .	14	1	8	2	7.80	7.00
Number of rooms hired, . . .	43	-	24	-	5.91	-
Rent paid, . .	48	1	27	2	$67.33	$156.00
Value of garden crops, . . .	31	1	18	2	$16.45	$5.00
Cost of living, .	151	27	85	52	$643.40	$191.26
Number of volumes in library, . .	30	1	17	2	327.37	350.00

BERKSHIRE COUNTY.

Whole Number of Schedules Received,—Males, 168; Females, 5[illegible]

SCHEDULE QUESTIONS.	NUMBER ANSWERING.		PER CENT ANSWERING.		AVERAGE FOR EACH [PER]SON ANSWERING	
	Males.	Females.	M.	F.	Males.	Femal[es].
Persons dependent,	108	3	64	5	2.93	[illegible]
Hours employed, .	144	58	86	100	10.38	[illegible]
Days employed, .	133	57	79	98	288.28	14[illegible]
Daily wages, . .	114	40	68	69	$3.14	$1.[illegible]
Yearly wages, .	155	58	92	100	$1,000.30	$221.[illegible]
Other earnings, .	39	6	23	10	$186.67	$3[illegible]
Wife's earnings, .	4	–	2	–	$135.50	
Children's earnings,	6	–	4	–	$174.17	
Unable to work, .	3	–	2	–	1.00	
Who own houses, .	33	1	20	2	1.00	1.[illegible]
Amount of mortgage, . . .	12	1	7	2	$1,991.67	$500.[illegible]
Rate of interest, .	9	1	5	2	7.00	8.[illegible]
Number of rooms hired, . . .	61	2	36	3	7.59	6.[illegible]
Rent paid, . .	61	2	36	3	$165.37	$109.[illegible]
Value of garden crops, . . .	37	2	22	3	$22.46	$18.[illegible]
Cost of living, .	134	32	80	55	$944.78	$210.[illegible]
Number of volumes in library, . .	41	3	24	5	422.66	150.[illegible]

Bristol County.

Whole Number of Schedules Received,—Males, 335; Females, 64.

SCHEDULE QUESTIONS.	Number Answering.		Per cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	225	2	67	3	2.84	1.00
Hours employed, .	292	60	87	94	10.56	6.78
Days employed, .	282	62	84	97	294.18	193.13
Daily wages, . .	249	60	74	94	$2.84	$1.93
Yearly wages, .	323	64	96	100	$966.57	$370.67
Other earnings, .	59	10	18	16	$234.80	$34.10
Wife's earnings, .	10	-	3	-	$205.50	-
Children's earnings,	17	-	5	-	$353.23	-
Unable to work, .	2	-	-	-	1.00	-
Who own houses, .	54	1	16	2	1.00	1.00
Amount of mortgage, . . .	13	-	4	-	$2,900.77	-
Rate of interest, .	13	-	4	-	7.40	-
Number of rooms hired, . . .	136	3	41	5	6.76	6.33
Rent paid, . .	136	4	41	6	$194.12	$186.00
Value of garden crops, . . .	28	-	8	-	$20.14	-
Cost of living, .	272	40	81	63	$877.37	$360.07
Number of volumes in library, . .	62	1	19	2	498.82	200.00

Whole Number c

SCHEDULE QUESTIONS.
Persons dependent,
Hours employed, .
Days employed, .
Daily wages, . .
Yearly wages, .
Other earnings, .
Wife's earnings, .
Children's earnings,
Unable to work, .
Who own houses, .
Amount of mortgage, . . .
Rate of interest, .
Number of rooms hired, . . .
Rent paid, . .
Value of garden crops, . . .
Cost of living, .
Number of volumes in library, . .

Essex County.

Whole Number of Schedules Received,—Males, 616; Females, 204.

Schedule Questions.	Number Answering.		Per cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	420	17	68	8	2.74	1.12
Hours employed, .	566	196	92	96	10.38	6.18
Days employed, .	529	174	86	85	288.25	211.61
Daily wages, . .	453	154	74	75	$2.91	$1.91
Yearly wages, .	581	199	94	98	$973.45	$422.25
Other earnings, .	122	18	20	9	$215.52	$65.61
Wife's earnings, .	18	-	3	-	$297.83	-
Children's earnings,	24	-	4	-	$227.79	-
Unable to work, .	11	2	2	1	1.00	1.00
Who own houses, .	143	8	23	4	1.00	1.00
Amount of mortgage, . . .	57	3	9	1	$1,906.93	$783.33
Rate of interest, .	57	3	9	1	7.40	7.30
Number of rooms hired, . . .	247	11	40	5	6.94	4.55
Rent paid, . .	253	11	41	5	$177.98	$112.18
Value of garden crops, . . .	64	4	10	2	$36.39	$90.00
Cost of living, .	441	114	72	56	$840.09	$352.71
Number of volumes in library, . .	131	10	21	5	401.13	174.70

FRANKLIN COUNTY.

Whole Number of Schedules Received,—Males, 132; Females, 50.

SCHEDULE QUESTIONS.	NUMBER ANSWERING.		PER CENT ANSWERING.		AVERAGE FOR EACH PERSON ANSWERING.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	95	1	72	2	2.55	1.00
Hours employed, .	111	50	84	100	8.66	6.06
Days employed, .	120	47	91	94	298.04	141.57
Daily wages, . .	95	44	72	88	$2.63	$1.37
Yearly wages, .	128	49	97	98	$868.41	$237.69
Other earnings, .	26	5	20	10	$129.50	$28.60
Wife's earnings, .	2	-	2	-	$85.00	-
Children's earnings,	6	-	5	-	$130.83	-
Unable to work, .	3	1	2	2	1.00	1.00
Who own houses, .	30	-	23	-	1.00	-
Amount of mortgage, . . .	17	-	13	-	$729.41	-
Rate of interest, .	17	-	13	-	7.10	-
Number of rooms hired, . . .	53	-	40	-	6.77	-
Rent paid, . .	54	-	41	-	$148.81	-
Value of garden crops, . . .	40	-	30	-	$26.75	-
Cost of living, .	102	15	77	30	$760.39	$197.40
Number of volumes in library, . .	38	1	29	2	403.24	200.00

Hampden County.

Whole Number of Schedules Received,—Males, 611; Females, 127.

Schedule Questions.	Number Answering.		Per cent. Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	450	12	74	9	2.64	1.50
Hours employed, .	545	127	89	100	10.55	6.32
Days employed, .	526	124	86	98	296.99	174.40
Daily wages, . .	358	92	59	72	$3.52	$2.22
Yearly wages, .	591	126	97	99	$1,117.70	$437.78
Other earnings, .	116	10	19	8	$205.97	$161.90
Wife's earnings, .	41	-	7	-	$151.32	-
Children's earnings,	20	1	3	-	$185.15	$62.00
Unable to work, .	9	-	1	-	1.11	-
Who own houses, .	121	1	20	-	1.00	1.00
Amount of mortgage, . . .	64	-	10	-	$2,749.30	-
Rate of interest, .	64	-	10	-	7.20	-
Number of rooms hired, . . .	276	13	45	10	6.30	3.60
Rent paid, . .	279	13	46	10	$203.26	$93.23
Value of garden crops, . . .	87	1	14	-	$14.21	$4.00
Cost of living, .	512	89	84	70	$986.61	$340.79
Number of volumes in library, . .	136	4	22	3	389.92	156.50

Hampshire County.

Whole Number of Schedules Received,—Males, 106; Females, 61.

Schedule Questions.	Number Answering.		Per cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	79	5	75	8	2.81	1.00
Hours employed, .	82	60	77	98	11.45	6.42
Days employed, .	82	59	77	97	295.66	148.27
Daily wages, . .	58	54	55	89	$2.46	$1.52
Yearly wages, .	100	61	94	100	$1,025.99	$227.82
Other earnings, .	25	9	24	15	$207.60	$24.78
Wife's earnings, .	2	-	2	-	$75.00	-
Children's earnings,	9	-	8	-	$177.55	-
Unable to work, .	2	-	2	-	1.00	-
Who own houses, .	21	1	20	2	1.00	1.00
Amount of mortgage, . . .	13	-	12	-	$2,607.70	-
Rate of interest, .	13	-	12	-	7.10	-
Number of rooms hired, . . .	37	-	35	-	6.35	-
Rent paid, . .	42	-	40	-	$163.57	-
Value of garden crops, . . .	17	-	16	-	$11.24	-
Cost of living, .	74	31	70	51	$1,026.96	$186.52
Number of volumes in library, . .	39	-	37	-	491.00	-

Middlesex County.

Whole Number of Schedules Received,—Males, 1,957; Females, 398.

Schedule Questions.	Number Answering.		Per cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	1,391	32	71	8	2.61	1.59
Hours employed, .	1,806	393	92	99	10.16	5.86
Days employed, .	1,635	361	84	91	293.84	208.55
Daily wages, . .	1,411	329	72	83	$3.18	$2.13
Yearly wages, .	1,851	393	95	99	$1,038.94	$455.44
Other earnings, .	272	33	14	8	$213.16	$145.45
Wife's earnings, .	59	-	3	-	$180.19	-
Children's earnings,	53	-	3	-	$238.38	-
Unable to work, .	33	2	2	-	1.12	1.50
Who own houses, .	464	10	24	3	1.00	1.00
Amount of mortgage, . . .	254	9	13	2	$2,305.74	$1,469.44
Rate of interest, .	250	9	13	2	7.50	7.60
Number of rooms hired, . . .	749	21	38	5	6.43	4.67
Rent paid, . .	744	18	38	5	$219.95	$180.83
Value of garden crops, . . .	117	1	6	-	$20.49	$70.00
Cost of living, .	1,490	254	76	64	$947.21	$375.46
Number of volumes in library, . .	334	13	17	3	362.44	211.54

Nantucket County.

Whole Number of Schedules Received,—Males, 17; Females, 3.

SCHEDULE QUESTIONS.	Number Answering.		Per cent Answering.		Average for each Person Answering.	
	Males.	Females.	M.	F.	Males.	Females.
Persons dependent,	12	-	71	-	2.33	-
Hours employed, .	17	3	100	100	8.00	6.00
Days employed, .	16	3	94	100	274 38	162.33
Daily wages, . .	10	3	59	100	$2.66	$1.29
Yearly wages, .	17	3	100	100	$801.00	$199.00
Other earnings, .	7	1	41	33	$93.57	$25.00
Wife's earnings, .	2	-	12	-	$65.00	-
Children's earnings,	-	-	-	-	-	-
Unable to work, .	1	-	6	-	1.00	-
Who own houses, .	6	-	35	-	1.00	-
Amount of mortgage, . . .	-	-	-	-	-	-
Rate of interest, .	-	-	-	-	-	-
Number of rooms hired, . . .	5	-	29	-	4.80	-
Rent paid, . .	5	-	29	-	$35.00	-
Value of garden crops, . . .	4	-	24	-	$14.50	-
Cost of living, .	10	2	59	67	$817.50	$237.50
Number of volumes in library, . .	4	-	24	-	245.25	-

Average for each Person answering each Inquiry—Concluded.

SCHEDULE QUESTIONS.	Suffolk.		Worcester.		For the State.	
	Males.	Females.	Males.	Females.	Males.	Females.
	2.54	2.20	2.60	1.60	2.64	1.63
	10.55	7.52	10.75	6.27	10.41	6.34
	296.62	257.36	289.37	172.25	290.29	192.37
	$3.16	$2.07	$2.93	$1.92	$3.09	$1.94
	$1,054.27	$572.50	$995.88	$519.74	$1,016.16	$429.36
	$265.02	$193.80	$228.13	$99.11	$216.13	$94.97
	$226.84	-	$146.53	-	$171.95	-
	$169.64	$575.00	$180.00	-	$201.89	$815.50
Unable to work,	1.17	1.00	1.19	1.00	1.13	1.11
Who own houses,	1.00	1.00	1.00	1.00	1.00	1.00
Amount of mortgage,	$3,377.68	$5,833.33	$2,799.31	$800.00	$2,452.71	$1,869.74
Rate of interest,	7.50	7.00	6.90	7.00	7.40	7.40
Number of rooms hired,	5.52	3.33	6.09	4.74	6.25	4.08
Rent paid,	$294.45	$191.76	$234.74	$189.15	$222.38	$154.78
Value of garden crops,	$20.11	-	$83.61	$8.83	$25.13	$38.77
Cost of living,	$984.67	$534.67	$868.72	$329.02	$913.35	$358.72
Number of volumes in library,	297.23	232.27	356.32	213.33	400.19	195.38

APPENDIX.

HISTORY

OF THE

BUREAU OF STATISTICS OF LABOR

AND OF

LABOR LEGISLATION IN MASSACHUSETTS.

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OF THE

BUREAU OF STATISTICS OF LABOR,

AND OF

LABOR LEGISLATION IN MASSACHUSETTS.

I.—INTRODUCTION.

The design of this appendix is to give a compendious narrative of the work of the Massachusetts Bureau of Statistics upon the subject of Labor, for the seven years commencing with May, 1869, and closing with May of the present year, 1876. The work has been undertaken for two reasons. The following letter supplies the principal one, and is in itself a sufficient authorization for what has been done:—

COMMONWEALTH OF MASSACHUSETTS.

EXECUTIVE DEPARTMENT,
BOSTON, July 27, 1875.

To the Chief of the Bureau of Statistics of Labor.

SIR:—The special committee of the executive council, to whom was referred the matter of the representation of the State at the Centennial Exhibition in Philadelphia, desire to call your attention to the importance of preparing an elaborate, and in some degree historical, report of the work of your department, which shall serve for presentation at the Exhibition, as well as for your next annual report.

Respectfully,

HORATIO G. KNIGHT,
SETH TURNER,
EDW. H. DUNN,
Committee.

The other reason for preparing a history of the bureau is found in the fact that its reports are out of print, and have been so generally called for, that it is impossible for the

bureau to supply a complete set of the volumes issued. The reports having been supplied only to those desiring them, and never having been placed on sale, there seemed to be no way of satisfying the requests of those wishing a complete set of the reports until the action of the above committee was taken. Their suggestion opened the way for bringing the work of this bureau to the attention of the whole country, and also for presenting the results of its investigations in a concise form for the use of individuals, libraries and governments. Possessing the opportunity of satisfying the demands of all interested in our work, we have aimed to merit the advantages conferred by following implicitly the suggestions of the committee of the governor's council. We do not contemplate a critical review of what has been done, nor do we intend to say more should have been done, or better done. Our aim has been to codify the results of the seven years' investigations, and present their pith in a compact manner. In fact, as far as possible, to give an exact and full presentation of seven reports in one. In all cases where practicable, the language of the reports themselves is given, rather than a rewritten presentation of their meaning.

To properly judge of the work of this bureau, a knowledge of the causes which led to its organization, its scope and power as fixed by law, its manner of working, is indispensable, and much labor has been expended to look up and arrange the information which follows concerning labor legislation in Massachusetts and foreign countries previous to and since the establishment of this bureau, the provisions of the organic law creating it, as regards money and breadth of action, and the subsidiary details explaining its manner of working and the obstacles it has encountered. If the information thus supplied leads to a better comprehension of the bureau's work, it will, for that reason, possess a value beyond its historic worth.

The decennial census and industrial statistics for 1875 having formed a special branch of the bureau's work for eighteen months, a full description of the undertaking from its inception to its practical fulfilment is hereinafter given. By the provisions of the law authorizing the bureau to take the census and gather the industrial statistics, the resulting

volumes are practically reports of statistics of labor, and the facts obtained really form part of the bureau work, and properly have a place in its history.

We have not deemed it inappropriate to present a few facts in relation to the future work of the bureau; not by suggesting new plans of action, but by showing how much more can be done with the facts already in possession of the department. The gathering of facts is a comparatively easy business; but their proper tabulation and application require time and thought, and the statistician should use both freely before issuing reports upon which are based the arguments or assertions of workingmen, students, political economists or statesmen. With this brief explanation of our underlying purposes, we begin the work before us.

II.—Labor Legislation from 1833 to 1863.

The following summary of laws passed by the Massachusetts legislature includes those which relate to or affect labor. This presentation of labor legislation for a period of thirty years, 1833–1863, is taken from the first report of this bureau:—

"Nothing specific is found in the volumes which cover the period prior to 1831.

"Governor Lincoln's address, January 8, 1833, appeals to the legislature for an equal participation of creditors in the effects of bankrupts, and for mitigation of imprisonment. He refers to having fully and repeatedly submitted his views to previous legislatures.

"The volume of state documents for 1831 contains the report of a special commission appointed by Governor Lincoln; this report was presented by him to the legislature June 1, 1831; it provides for an equal distribution of assets, and by one of its sections proposes to abolish imprisonment for any debt of less than fifty dollars.

"March 12, 1833, an Act of incorporation was granted to the South Reading Mechanic and Agricultural Institution, 'for encouragement to agriculture and the mechanic arts, and for relieving the distresses of unfortunate mechanics and their families.'

"March 19, 1833, an Act was approved by the governor, releasing civil officers from suit in case of the escape of a debtor from prison.

"February 28, 1834.—Worcester County Manual Labor High School incorporated.

"March 6, 1834.—Berkshire County Manual Labor High School incorporated.

"March 31, 1834.—Act abolishing imprisonment for debt approved.

"Chap. 245, vol. 13, Laws of Massachusetts, 1834 to 1836.—An Act to provide for the better instruction of youth employed in manufacturing establishments. This Act requires three months' schooling each year; employer fined fifty dollars for violating. *App. April* 16, 1836.

"The address of Governor Davis to the legislature of 1835 (House Doc., No. 3), deplores the low repute of the state militia, and states that it is probably the bitter fruit of unsatisfactory laws.

"Chap. 107, vol. 14, Laws of Massachusetts, 1837–38.—An Act to provide for the better instruction of youth in manufacturing establishments. This Act provides for the release of the employer from the penalty, in case he is provided with a sworn certificate of attendance at school.

"Chap. 58, Laws of 1839, incorporates the Charlestown Mechanics' Union Charitable Association, with the powers set forth in the 44th chapter of the Revised Statutes.

"Chap. 54, Laws of 1841.—Danvers Mechanic Institute incorporated.

"Chap. 49, Laws of 1843.—Boston Society for the Diffusion of Information among Emigrants incorporated.

"Chap. 169, Acts of 1845.—Brook Farm Phalanx incorporated, 'for the purpose of promoting education, agricultural knowledge and habits of manual and mechanical industry.' Powers and liabilities set forth in the 38th and 44th chapters of the Revised Statutes.

"Chap. 171, Acts of 1845.—An Act to obtain statistical information in relation to certain branches of industry.

"Chap. 99, Acts of 1845.—Act granting one-half of a township in Maine, six miles square, to the Worcester County Manual Labor High School.

"Chap. 220, Acts of 1849.—An Act defining and repealing sections of previous Acts concerning the employment of children.

"Chap. 294, Acts of 1850.—Cities and towns authorized to make all needful provisions concerning truants and children not attending school.

"Chap. 66, Acts of 1850.—An Act incorporating the Worcester County Mechanics' Association; 'purpose to promote moral and intellectual improvement, perfect the mechanic arts, and for charitable purposes.'

"Chap. 343, Acts of 1851.—An Act to secure to mechanics and laborers their payment for labor by a lien on real estate.

"Chap. 240, Acts of 1852, 'requires all persons having children under their control to send them to school three months each year.'

"Chap. 307, Acts of 1852.—Extension of the principles of the lien law.

"Chap. 313, Acts of 1852.—An Act to incorporate the Suffolk Mutual Loan and Accumulating Fund Association; 'object of the association to loan funds to those contributors who wish to purchase homesteads.'

"Chap. 238, Acts of 1852.—General truant law.

"Chap. 343, Acts of 1853.—City truant law.

"Chap. 392, Acts of 1854.—An Act to incorporate the Model Lodging House Association.

"Chap. 309, Acts of 1855, requires school committees to report violations of the law of May, 1852, to the treasurers of their towns and cities.

"Chap. 379, Acts of 1855, amends the Act of May, 1849, concerning children.

"Chap. 18, Acts of 1855.—Act incorporating an industrial school for girls. Lucretia O. Everett and others.

"Chap. 444, Acts of 1855.—An Act abolishing imprisonment for debt, except in cases of fraud.

"Chap. 431, Acts of 1855.—Amendment to lien law.

"Chap. 231, Acts of 1855.—Extension of the lien law to ships and vessels.

"Chap. 141, Acts of 1857, consolidates the Acts concerning imprisonment for debt and the punishment of fraudulent debtors.

"Chap. 50, Acts of 1857, requires the insurance commissioners to report annually the conduct and condition of the loan fund associations.

"Chap. 83, Acts of 1858, requires eighteen weeks' schooling.

"Chap. 55, Acts of 1858.—Amendment to lien law.

"Chap. 188, Acts of 1859.—School committees required to give notice to treasurers of violations of the Act of 1852; treasurer fined if he fails to comply.

"Chap. 166, Acts of 1863.—An Act to provide for the reception of a grant of Congress, and to create a fund for the promotion of education in agriculture and the mechanic arts."

The preceding summary shows secured legislation, but gives no indication of the causes which led to the passage of the various laws. It is difficult to trace the origin and course of

the various labor reform movements. The attempts to secure a reduction of the hours of labor are, however, quite fully recorded. The following information, indicating the opinions and showing the actions of workingmen themselves, is gleaned from official sources.

In September, 1832, a convention of delegates from the farmers, mechanics and workingmen of New England was held in the representatives' hall of the state house. Grievances were discussed, and resolutions and an address adopted, setting forth the burdens under which the laboring classes suffered from excessive hours, imprisonment for debt, the lack of a lien law, onerous militia service, and various other causes. (See preceding summary for legislation in 1833.)

January 21, 1834, a meeting to form a general trades' union was called at the Boston common council room, and a committee appointed to carry the plan into effect. In March, a constitution was submitted and ratified by the trades. The union, on the Fourth of July, had a procession, with two thousand men in line, an oration and dinner. The oration was delivered in the open air on Fort Hill by Frederick Robinson, Esq. The dinner took place at Faneuil Hall. The committee of arrangements apologized for the absence of a clergyman at the banquet, and stated that application was made to twenty-two religious associations for the use of a church in which to deliver the oration, but their request was in every case refused. Consequently no clergyman was invited to ask a blessing.

October 6, 1830, Edward Everett delivered a lecture on labor before the Charlestown Lyceum. Among other things, he said: "If, as I have endeavored to show, man is by nature a working being, it would follow that a workingmen's party is founded in the very principles of our nature. . . . But the workingmen's party, however organized, must subsist in every civilized country to the end of time."

November 13, 1831, he spoke again before the Franklin Institute of Boston, but did not take ground in favor of a reduction of hours.

Between 1830 and 1840, Rev. William Ellery Channing delivered many addresses and lectures on the elevation of the laboring classes. In one he said: "We do not find that civ-

ilization has lightened men's toils: as yet it has increased them; and in this I see the sign of a deep defect in what we call the progress of society."

In September, 1834, a meeting of workingmen in Boston chose ten delegates to a convention of farmers, mechanics and others, to be holden at Northampton later in the same month.

In 1835, the authorities of the city of Boston refused the use of a hall for an evening meeting to discuss the ten-hour movement.

In 1833, '34 and '35, it is stated that a workingmen's party existed, and chose candidates for governor, etc.

In 1836, the Hon. James G. Carter, chairman of the committee on education, in a report to the legislature, spoke of the "constant inducement to manufacturers to employ female labor and the labor of children, to the exclusion of men's labor, because they can be had cheaper."

In 1837, the State instituted inquiries concerning the products of industry of the population, somewhat similar to those instituted by the United States in 1840, but the results were exceedingly erroneous. (See House Document, No. 124, 1849.)

April 10, 1840, President Van Buren issued the order directing "that all public establishments will hereafter be regulated, as to working hours, by the ten-hour system."

In his report for 1840, the Hon. Horace Mann wrote earnestly concerning the school laws of 1837–38, and of the necessity of limiting the greed of heartless employers and unnatural parents. In 1842, the hours of labor of children under twelve were limited to ten per day.

In 1844, the ten-hour plan was established in most of the ship-building trades in the State. In 1853, many trades were working but ten hours. The shipwrights and calkers increased their prices to three dollars per day, and worked but a trifle over eight hours.

The preceding facts are necessarily given in a fragmentary way. The movement for the reduction of the hours of labor did not step forward impressively, gaining strength from year to year, but was fitful in its expression. For this reason the thread is wanting to make a history of labor legislation harmonious.

In 1845 (House Document, No. 50) petitions were introduced to the legislature praying for the regulation of the hours of labor in corporations, eleven hours being the fixed time desired. The petitioners numbered 2,138, of which Lowell supplied 1,150; Andover, 500; and Fall River, then a town, 488. The matter was referred to a committee, who reported against any legislation. They gave as reasons, that it was unjust to regulate hours for corporations, when private individuals would be free from the operations of such a law. They stated their belief, that factory labor was no more injurious than other kinds, that wages would necessarily have to be reduced if such a law was passed, and that other States would distance Massachusetts in the markets of the world. To use their own words, such law would "close the gate of every mill in the State." No action was taken by the legislature beyond accepting the report of the committee.

The question of hours remained dormant, as regarded the legislature, until 1850 (House Document, No. 153). The committee considering the subject, elicited the following information: The Lowell mills were running twelve hours (11 h. $58\frac{2}{3}$ m.) daily, or fourteen hours more per week than English mills. It was also found that, of 2,611 young girls, averaging twenty-two years of age, who had entered the mills six years before in good health, 878, or thirty-three per cent, had deteriorated sadly, dyspepsia being the prevailing complaint.

The majority report considered legislation inexpedient; but the minority reported a bill establishing *eleven* hours as the legal day on and after September 1, 1850, and *ten* hours on and after July 1, 1851. Again was legislation postponed.

Two years elapsed before the subject came up again. In 1852 (House Document, No. 185), an attempt was made to have ten hours made the legal day, in the absence of a special contract, and providing that children under fifteen should not work more than ten hours; but the bill failed.

Another rejected plan provided for *twelve* hours on and after July 4, 1852, *eleven* hours October 1, 1852, and *ten* hours July 4, 1853. The usual exceptions were made in case of repairs, etc.

III.—LABOR LEGISLATION FROM 1864 TO 1868.

Governor Bullock's address for 1866 contains the following allusions to—

"*The Questions of Labor.*

"It will be my duty to communicate to the legislature, when received, the report of the commissioners appointed under a Resolve of the last general court, to consider the interests and the hours of labor. In the absence of their report, I omit a general consideration of the subject. The question of the hours of labor is not merely one of sanitary connections, but it relates to the social condition of a State. Considered in this broad sense, it is at all times entitled to careful and respectful investigation. There are volumes of evidence exhibiting the degree of attention which the subject has from time to time received from the parliament of Great Britain. Having myself no hesitation as to the rightful authority of the legislature over the subject, and believing that a concession to the wishes of those who seek for a thorough inquiry will be productive of a better understanding, not only of the specific question itself, but of the intimate and mutually beneficial relations which all classes sustain to each other, I submit the matter to your wisdom."

The succeeding abstract of secured labor legislation, from 1864 to 1868, is copied mainly from the First Bureau Report.

"Chap. 116, Acts of 1865.—Act to incorporate the Boston Labor Reform Association, for the purpose of improving the condition of the mechanic and laboring classes in their various occupations, etc.

"Chap. 62, Acts of 1865, appoints an unpaid commission of five to collect information and statistics in regard to the hours of labor and the condition and prospects of the industrial class.

"Chap. 206, Acts of 1865, exempts from attachment the tools of a mechanic to the amount of not more than three hundred dollars.

"Chap. 270, Acts of 1865, amends the apprenticeship law, by repealing imprisonment, and substituting a bond.

"Chap. 290, Acts of 1866.—Act authorizing the formation of co-operative associations.

"Chap. 67, Acts of 1866.—The business hours of the departments of the state government to be determined by the governor and council.

"Chap. 273, Acts of 1866.—An Act in relation to the employment of children in manufacturing establishments.

"SECT. 1. No child under the age of ten years shall be employed in any manufacturing establishment within this Commonwealth, and no child between the age of ten and fourteen years shall be so employed, unless he has attended some public or private school under teachers approved by the school committee of the place in which such school is kept, at least six months during the year next preceding such employment; nor shall such employment continue unless such child shall attend school at least six months in each and every year.

"SECT. 2. The owner, agent or superintendent of any manufacturing establishment, who knowingly employs a child in violation of the preceding section, shall forfeit a sum not exceeding fifty dollars for each offence.

"SECT. 3. No child under the age of fourteen years shall be employed in any manufacturing establishment within this Commonwealth, more than eight hours in any one day.

"SECT. 4. Any parent or guardian who allows or consents to the employment of a child, in violation of the first section of this act, shall forfeit a sum not exceeding fifty dollars for each offence.

"SECT. 5. The governor, with the advice and consent of the council, may, at his discretion, instruct the constable of the Commonwealth and his deputies to enforce the provisions of chapter forty-two of the General Statutes, and all other laws regulating the employment of children in manufacturing establishments, and to prosecute all violations of the same.

"Chap. 92, Resolves of 1866.—Resolve authorizing the appointment by the governor of a commission of three persons to investigate the subject of the hours of labor in its relation to the social, educational and sanitary condition of the working classes.

"Chap. 85, Resolves of 1866.—Resolve appropriates ten thousand dollars for representation of industries of the State at the Universal Exposition in 1867 at Paris.

"Chap. 285, Acts of 1867.—An Act in relation to the schooling and hours of labor of children employed in manufacturing and mechanical establishments.

"SECT. 1. No child under the age of ten years shall be employed in any manufacturing or mechanical establishment within this Commonwealth, and no child between the age of ten and fifteen years shall be so employed, unless he has attended some public or private day school under teachers approved by the school committee of the place in which such school is kept, at least three months during the year next preceding such employment: *provided*, said child shall have lived within the Commonwealth during the preceding six months; nor shall such employment continue unless such child shall attend school at least three months in each and every year; and *provided*, that tuition of three hours per day in a public or private day school approved by the school committee of the place in which such school is kept, during a term of six months, shall be deemed the equivalent of three months' attendance at a school kept in accordance with the customary hours of tuition; and no time less than sixty days of actual schooling shall be accounted as three months, and no time less than one hundred and twenty half-days of actual schooling shall be deemed an equivalent of three months.

"SECT. 2. No child under the age of fifteen years shall be employed in any manufacturing or mechanical establishment more than sixty hours in one week.

"SECT. 3. Any owner, agent, superintendent or overseer of any manufacturing or mechanical establishment, who shall knowingly employ or permit to be employed, any child, in violation of the preceding sections, and any parent or guardian who allows or consents to such employment, shall for such offence forfeit the sum of fifty dollars.

"SECT. 4. It shall be the duty of the constable of the Commonwealth to specially detail one of his deputies to see that the provisions of this act and all other laws regulating the employment of children or minors in manufacturing or mechanical establishments, are complied with, and to prosecute offences against the same; and he shall report annually to the governor all proceedings under this act; and nothing in this section shall be so construed as to prohibit any person from prosecuting such offences.

"SECT. 5. Chapter two hundred and seventy-three of the acts of the year eighteen hundred and sixty-six is hereby repealed: *provided*, this act shall not affect any proceedings now pending.

"SECT. 6. This act shall take effect sixty days from its passage.

"Chap. 174, Acts of 1867.—The Co-operative Mills incorporated.

"Chap. 264, Acts of 1867.—Shares in co-operative associations to the value of twenty dollars exempted from attachment and execution.

"Chap. 95, Acts of 1868.—Wages of wife and minor children of debtor exempted from attachment.

"Chap. 279, Acts of 1868.—Overseers of poor prohibited from removing minors from the State."

A careful search makes manifest many of the causes which led to the passage of the preceding laws. In 1865, eighteen weeks' schooling was required for all working children under twelve, and twelve weeks for those between twelve and fifteen.

March 8, 1865, Major John W. Mahan, a member of the House of Representatives from Boston, offered, so far as is known entirely on his own responsibility, the following Order:—

"*Ordered*, That the Judiciary Committee consider the expediency of regulating and limiting the number of hours constituting a day's labor, and of making it a penal offence for any employer to require an employé to labor beyond such number of hours as may be prescribed by law."

[The Order contained, also, a clause against combinations by dealers to advance the price of the necessaries of life.]

The Order and petitions were referred to a joint special committee, which reported by its chairman, on the part of the House, Mr. Edward H. Rogers of Chelsea, a Resolve asking for the appointment of an unpaid commission of five to investigate the subject of the hours of labor. The Resolve was passed, and approved by Governor Andrew. He selected the following gentlemen to constitute the commission: William P. Tilden, Henry I. Bowditch, F. B. Sanborn, Elizur Wright and George H. Snelling. Their report was made February 7, 1866 (House Document, No. 98), and will be considered farther on.

In 1866, the legislature passed the following Resolve:—

> "That a commission of three persons be appointed by the governor, with power to send for persons and papers, to investigate the subject of the hours of labor, especially in its relation to the social, educational and sanitary condition of the industrial classes, and to the permanent prosperity of the productive interest of the State."

The commission was composed of Amasa Walker, William Hyde and Edward H. Rogers. The two first named made a majority report, and the latter submitted a minority report. The report was presented January 1, 1867 (House Document, No. 44), and will be examined in its important details in the next section of this volume.

The factory agitation of 1867 resulted in the Act amending that of 1866 (both are given on page 14), and General H. K. Oliver was appointed a special state constable to enforce its provisions.

June 24, 1868, the national eight-hour law was passed, and went into operation at the Charlestown navy yard, July 6. In the spring of 1869, the workmen were informed that their pay would be reduced one-fifth. This led to complications from which relief was found in the proclamation of President Grant, dated May 21, which directed that no reduction in wages should be made on account of reduction in hours.

IV.—Reports of two Commissions on Hours of Labor—1866 and 1867.

In February, 1866, the commission appointed by Governor Andrew, in accordance with a Resolve of the legislature of 1865 "to collect information and statistics in regard to the

hours of labor, and the conditions and prospects of the industrial classes," made their report, which was signed by the five commissioners previously named. We present a brief abstract of their report.

One thousand printed circulars were sent out, and eighty replies received. Thirty-nine out of 334 towns and cities responded. The education of children in manufacturing districts was first considered, and the commissioners said "a saddening amount of testimony has been brought before the commission concerning the frequent and gross violation" of the school law, which then required *eleven weeks'* schooling yearly for children from twelve to fifteen years of age, and *eighteen weeks* for children under twelve. The latter were not allowed to work more than *ten* hours per day. After expressing the fear that Massachusetts was in danger of "rushing into the same fearful condition in which England found her manufacturing districts years ago," they continue:—

"As our common-school system is so thoroughly established, and as all our manufacturing villages have, more or less, a mixed population, the children of merchants, mechanics and factory operatives attending the same school, it *may* be difficult (although the commission is not unanimous on that point) to adopt the half-time plan in detail; but we may secure a part, at least, of its beneficial results, by demanding the same amount of schooling, as now indicated in the statutes, every *six* months, instead of every *twelve* months, as now provided; thus doubling the amount of schooling, and lessening correspondently the amount of labor.

"But with the view of encouraging, as fast and as far as practicable, the 'half-time system,' we would have it provided that, in all cases where this system is adopted and carried out in good faith, the laws in the sections referred to shall not be considered binding.

"We suggest, also, that a suitable person or persons be appointed by the governor, and clothed with full power of inspection, whose duty shall be to *see that the laws* concerning this subject be faithfully obeyed, and to bring suits when they are violated. Such officers should report annually to the legislature the condition and wants of that class of children to which the law refers."

In considering the pecuniary value of healthy men, a man's worth to the State (wages earned) is put at $27,000, and the point made that the State cannot afford to allow children to

labor in a way to impair health and shorten life. The pecuniary value of education is demonstrated, and the commissioners state their belief in the assertion that illiterate help *never yields proprietors a profit!*

After presenting some statistics concerning hours of labor, the commissioners say :—

"From this brief summary it appears that what is known as the 'ten-hour system' is generally adopted in mechanical employments, and that eleven hours is the general rule in cotton factories. The shortest time established by custom for a day's labor is that adopted by the class of shipwrights engaged on 'old work,' seven hours forty minutes. The longest time is seventeen and one-half hours, adopted in a few bakeries."

After considering testimony given relative to the evil results of such long hours of labor as are required in bakeries, they add :—

"If these statements can be relied on, the commission are of opinion that in no branch of industry that has been presented to their consideration is there greater need of reform than in this, which furnishes us with the staff of life; and they would express their hearty sympathy with the bakers in their efforts to lessen the hours of labor, hoping the needed change may soon be accomplished."

The wages of women were next considered, but with no practical result, the information derived upon the subject being very meagre.

The commission, after presenting the arguments, *pro* and *con*, for a reduction of the hours of labor (touching, in their considerations, upon such points as province of law, law of usury, overwork,* hasty meals, labor-saving machinery, eleva-

* Every man has a certain amount of constitutional force. This is his vital capital, which must not be diminished. Out of this comes daily a certain and definite amount of available force, which he may expend in labor of muscle or brain, without drawing on his vital capital. He may, and he should, work every day, and expend so much force, and no more, that he shall awake the next morning, and every succeeding morning, until he shall be threescore and ten, and find in himself the same amount of available force, the same vital income, the same power to do his ordinary and healthy day's work, and again lay down at night with his capital of life, his constitutional force, unimpaired.—*Letter to Commission from Edward Jarvis.*

tion of labor by the workingman himself),
lowing conclusion regarding an eight-hour l

"The Commission, therefore, are opposed to eight-hour law.

"1. Because they deem it unsound in principle t of time to all kinds of labor.

"2. Because, if adopted as a general law, in t would be rendered void by special contracts, an the dead laws that cumber the statutes.

"3. Because a very large proportion of the in the country *could not* observe it.

"4. Because, if restricted, as some propose, the State, it would be manifestly *partial*, and, th

On the general subject of a reduction of ion is given as follows:—

"The commission believe that the change de brought about by workingmen outside the st legislators inside."

The report thus concludes:—

"It may be well for convenience of reference in closing, the three distinct recommendations sion have ventured to make to your honorable bo

"1. That a change be made in the statutes co ing and work of children in manufacturing dis them twice the amount of schooling now require full what is known as the 'half-time system.'

"2. That an inspector, or inspectors, be app the enforcement of these laws, and also to look put to apprenticeship, or otherwise bound to ser to see that they are properly cared for accordi indentures.

"3. That provision be made for the annual c statistics, in regard to the condition, prospects industrial classes.

"Respectfully submitted by "WILLIA
"HENRY
"F. B. S
"ELIZUR
"GEO. H

The commission on the hours of labor, appointed under chap. 92 of the Resolves of 1866, reported to Gov. Bullock, January 1, 1867. We will consider the majority report first. Some 450 circulars were sent out, but the statistics obtained were not deemed of great value. Speaking of the Act of 1866, chap. 273, which provides that "no child under ten years of age shall be employed in any manufacturing establishment within this Commonwealth," the commissioners say, "we know that there is a general, but, we are happy to say, not universal disregard" of the law. Eleven hours was found to be the rule in factories, and the commissioners remark thereon: "Eleven hours' toil each day for six days in each week is more than women and children ought to be required to perform."

The commissioners, after thoroughly weighing the testimony they had secured, presented the following recommendations to the governor:—

"1. That the Act of the last session, chapter 273, be so amended as to insure the execution of those provisions which forbid the employment of children between the ages of ten and fourteen, and provides for their attendance at school.

"2. That the employment of all persons under the age of eighteen years in factories, for more than ten hours each day, or sixty hours per week, be prohibited; and that one hour each day shall be allowed for dinner.

"3. That a special INSPECTOR OF LABOR be appointed, to see that all laws relating to the interests of the laboring classes are faithfully executed.

"4. That a Bureau of Statistics be established for the purpose of collecting and making available all facts relating to the industrial and social interests of the Commonwealth."

On the general question of reduction of hours of labor, the commissioners did not believe in law-making. They thought public sentiment should induce the employer to shorten the hours in certain trades, especially in the winter season. They argued strongly in favor of making the *hour* the unit of time in relation to labor, and suggested it might be well to enact that no contracts for labor not made upon the hour standard should be recognized in law.

In conclusion, the commissioners said,—

"The undersigned would respectfully represent to your Excellency that they cannot recommend the enactment of any law restricting the hours of labor for the *adult* population of the Commonwealth.

"AMASA WALKER.
"WILLIAM HYDE."

Mr. Edward H. Rogers, in making his minority report, states his belief in three "truths,"—

"*First.* Manual labor is the divine training to energize the character.

"*Second.* The more hours men work in any staple branch of manufactures, the less they receive in the form of wages.

"*Third.* Labor *is* capital."

One of the principal conclusions arrived at by the commissioner, is,—

"Human labor is so connected with exalted mental and moral capacities, that it of right ought to have higher consideration than merchandise."

He closed his report as follows:—

"I recommend, as the result of my investigations, and in view of the expressed wish of the interest of labor in the factories, and, so far as ascertained, on the farms, the enactment of ten hours as a legal standard for a day's labor—in the absence of contracts—for farm and factory work; and a similar enactment of eight hours as a legal standard—in the absence of contracts—for mechanical labor.

"Respectfully submitted, by
"EDWARD H. ROGERS,
"*Commissioner on the Hours of Labor.*"

V.—LABOR LEGISLATION IN 1869.—ESTABLISHMENT OF THE BUREAU OF STATISTICS OF LABOR.

Since 1866 no especial executive attention had been given to labor reform in any of its phases. The following Acts and Resolves were, however, passed by the legislature of 1869:—

"Chap. 302, Acts of 1869, provides for cancelling the indentures of wards of the State in certain cases.

"Chap. 305, Acts of 1869, provides that towns and cities may maintain evening schools for those over twelve years of age.

"Chaps. 57 and 72, Resolves of 1869, appropriate fifty thousand dollars to the Worcester County Free Institute of Industrial Science, with a proviso for gratuitous instruction.

"Chap. 102, Resolve of 1869, provides for the establishment of a Bureau of Statistics of Labor."

The full text of the Resolve establishing the bureau is given below:—

"RESOLVE providing for the establishment of a Bureau of Statistics on the subject of Labor.

"*Resolved*, That the governor, with the advice and consent of the council, is hereby authorized to appoint, as soon after the passage of this resolve as may be, and thereafter biennially in the month of May, some suitable person to act as chief, who shall have power to appoint a deputy, and said chief with his deputy shall constitute a bureau of statistics, with headquarters in the state house.

"The duties of such bureau shall be to collect, assort, systematize and present in annual reports to the legislature, on or before the first day of March in each year, statistical details relating to all departments of labor in the Commonwealth, especially in its relations to the commercial, industrial, social, educational and sanitary condition of the laboring classes, and to the permanent prosperity of the productive industry of the Commonwealth.

"That said bureau shall have power to send for persons and papers, to examine witnesses under oath, and such witnesses shall be summoned in the same manner, and paid the same fees as witnesses before the superior courts of the Commonwealth. The compensation of said bureau shall be twenty-five hundred dollars annual salary for the chief, and two thousand dollars annual salary for the deputy. And the governor is hereby authorized to draw his warrant for the payment of said sums, together with such office and travelling expenses of said bureau, as he with the council shall approve."

It is undoubtedly useless to try to explain the *immediate* reasons which led to the establishment of the bureau. The preceding commissions on the hours of labor had recommended such a bureau, but the matter had laid dormant for two years. The connection of the various labor elements with its passage is not obvious. The legislature had shown but little intention of legislating for labor. The eight-hour men had put in no petitions. The petitions (two in number) for a ten-hour law

had been referred to the next general court. The petitions of the Crispins for an Act of incorporation were referred to the committee on manufactures, and they granted leave to withdraw. A substitute bill in place of the report was rejected in the Senate by a vote of 5 to 22.

At this juncture, it has been stated, fears were entertained that the labor vote would be lost, and it was suggested it would be politic to grant some concession to labor. This may be true; if so, the legislature of 1869 created the bureau, and not the petitions and labors of the workingmen.

The petition of Wendell Phillips and others, relative to the hours of labor, was introduced in the House, February 6, and was referred to a joint special committee of seven from the House and three from the Senate. This committee did not report until June 9, and in the meantime the petitions of the Crispins and ten-hour men had been acted upon adversely. June 12, in the Senate, the Resolve creating the bureau was rejected on its passage to a third reading by a vote of 10 to 14. This vote was reconsidered on the 14th, the Resolve passed to a third reading, and, under suspension of the rules, to be engrossed. After being amended in the House, and again in the Senate, the Resolve finally passed and received the governor's approval, June 22.

The idea that the creation of the bureau was a matter of policy, may gain color from the legislative proceedings; but it should be remembered that the idea of such a bureau had been before the public for three years, and there could be no good reasons given for not having such a department. Again, the Resolve at first was loosely drawn, especially as regarded expenditures, and the House committee on finance thought it ought not to pass. That the financial objection was not a trivial one, is established by the fact that extra legislation as regarded expenses of the bureau became necessary in 1870. We do not presume to settle the question, whether or not the bureau was created from motives of policy; but there are many indications from the records of the time, that the public sentiment, if not particularly in favor of systematic investigation, was not against it. The bureau was simply to be a standing committee of investigation, and in establishing it, those

who voted for it committed themselves to no particular plan of labor reform.

Another argument that undoubtedly led in some measure to the establishment of the bureau was found in the reports of General H. K. Oliver, in relation to the education and employment of children in factories. The first report made by him on the subject was dated January, 1868 (Senate Document, No. 21). He reported no convictions under the so-called "school law," and pointed out nine points of feebleness therein which rendered it practically inoperative. As he said, *one* man could not be expected to visit *every* manufacturing establishment in the State, and only 19 per cent answered circulars sent to them. It could not be reasonably supposed that manufacturers would so fill out circulars as to criminate themselves. If the law had been a strong one, one man could have done much, for a conviction in one town would have had a salutary effect throughout the State. The important points gathered from circulars filled, showed that 151 out of 335 establishments employed children, 30 of which required more than 60 hours of labor from them each week. Thirty-eight evening schools for factory and other working children were in operation.

The second report made by General Oliver (Senate Document, No. 44, 1869) was, in spirit, a reproduction of that of 1868. The word "knowingly" in the statute was deemed the weakest point, and convictions were impossible, appeals and exceptions being necessarily allowed by the courts.

Although the parents and guardians were amenable to the law as well as employers, and although the word "knowingly" did not apply to them, no attempts were made to prosecute them. The report closed with a recommendation of the English half-time system, and a suggestion that matters relating to the education of working children be taken from the charge of the state constabulary, a police institution, and placed in the hands of the State Board of Education.

VI.—Labor Legislation from 1870 to 1876.

The following forms part of Governor Claflin's inaugural address in 1870:—

"*The Labor Question.*

"The condition of labor demands our earnest attention. The skill and energy which produce the material results which we witness everywhere should not be overlooked or forgotten. Though favorably located for commerce and manufactures, our position would be valueless but for the untiring industry which makes use of these opportunities. Our future success in manufacturing depends upon the intelligence and faithfulness of our laborers.

"Public policy, then, would justify special care of all their interests on the part of the legislature. Accordingly, commissioners have examined the subject, and from their reports and suggestions have resulted laws intended for their benefit. It is to be hoped that whatever suggestions or requests may be made to you by this large class of our fellow-citizens, coming within the legitimate scope of legislation, may receive most careful and cordial consideration."

Legislation was secured as follows:—

"Chap. 281, Acts of 1870.—Grand Lodge of the Knights of St. Crispin incorporated.

"Chap. 48, Resolves of 1870.—State Board of Health directed to ascertain rate of mortality among minors employed in the textile industries.

"Chap. 74, Resolves of 1870.—Pay of assistants in Bureau of Statistics of Labor defined."

The only legislation having particular reference to the bureau was the passage of the following Resolve; its object was to fix the expenditures of the bureau by law, and thus remove a responsibility and unnecessary detail work from the governor and council.

"RESOLVE concerning the Bureau of Statistics of Labor.

"*Resolved*, That the chief of the bureau of statistics of labor be and hereby is authorized to employ such assistants and incur such expense, not exceeding the sum of five thousand dollars, as may be necessary in the discharge of his official duties; said assistants to be paid in full for their services such compensation as the chief may deem just and equitable: *provided*, that no assistant be paid more than four dollars per day, in addition to his necessary travelling expenses."

The eight-hour and ten-hour men were early in the field, and conducted the campaign of 1870 with earnestness. Forty-five petitions for a ten-hour law for women and children were presented in the House, and sixty-four in the Senate. After a hard and protracted parliamentary warfare, a bill was passed to be engrossed in the House by a vote of 133 to 67. This bill was refused a third reading in the Senate. Fifteen petitions for an eight-hour law, to apply to employés of the State, cities and towns, were presented in the House, and eight in the Senate. Such a bill was passed to be engrossed by the Senate, and rejected by the House on its passage to a third reading. Thus the two branches were quits, for each had blocked the other's action in precisely the same manner.

Four petitions were introduced in favor of a Resolve to establish "institutions for women," but no action was taken.

Labor Legislation in 1871.

Governor Claflin incorporated the following remarks on the labor question in his address for 1871, and the matter was referred to the usual joint special committee of eleven, three from the Senate, and eight from the House.

"*The Labor Question.*

"As the guardians of the public welfare, you are called upon to do everything that legislation can properly effect to improve the physical, mental and moral condition of your constituents, especially of those whose daily toil contributes so largely to the prosperity of our vast manufacturing interests. To promote this end the Board of Health are actively pursuing their investigations into the sanitary condition of manufactories and the dwellings connected with them.

"The Bureau of Labor is also particularly charged to inquire into and secure the enforcement of laws in regard to the schooling of children, and to report on the general condition of the productive industry of the Commonwealth. In the last twenty years, legislation has been wise and efficient in behalf of this important interest, but there is still room for advance, and the time has now come to inquire whether the hours of labor in manufactories, established by law, may not be limited with great advantage to both employers and the employed. Of course this does not directly affect the question of wages, which cannot properly be determined by legislation. The

report of the Bureau of Labor, containing many interesting statistical statements, will soon be laid before you for your information."

Three Acts and one Resolve passed, as given below, had special reference to labor and laborers.

"Chap. 280, Acts of 1871.—Tenement or lodging-house Act provides for ventilation, fire-escapes, sewerage, etc., therein.

"Chap. 323, Acts of 1871.—Women's Economical Garden Homestead League incorporated.

"Chap. 324, Acts of 1871.—Boston Co-operative Building Company incorporated.

"Chap. 82, Resolves of 1871.—Bureau of Statistics of Labor directed to prepare a plan for a system of half-time schools."

The ten-hour law again received legislative attention. Twenty-two petitions for such a law were presented in the Senate and twenty-six in the House. A ten-hour bill was passed to a third reading in the House by a vote of 131 to 46, was amended and engrossed, 100 to 61. The Senate refused a third reading, 8 to 26.

The petitions for an eight-hour law, for employés of the State, cities and towns, numbered eight in the Senate, and eight in the House, but both branches referred them to the next general court.

Besides the above petitions, three were introduced in favor of "Garden Homesteads" for women, and one for a half-time school law for working children.

Labor Legislation in 1872.

The newly elected Governor Washburn, in his address, considered at length the growing and ever-recurring problem of—

"*The Labor Question.*

"I commend to your candid and cordial consideration the varied interests of those who are denominated the laboring portion of our citizens. The question of practical concern is not so much whether the condition of this class is better or worse here than in other sections of the country, as whether that condition is satisfactory, whether it is what it might be made by honest and resolute endeavor, what it should be made by those who have the well-being of the Commonwealth deeply at heart. To this question I am sure no one will

venture an affirmative reply. Neither is it of paramount importance to determine whether the situation of this large body of persons is better or worse than it was formerly. Our view should be forward, and not backward.

"Many seem to hold the opinion that if the workingmen and workingwomen, as they are commonly designated, receive constant employment and are adequately remunerated; if they gain the needful bread and meat in exchange for their labor; if they have comfortable homes and enough for the decent support of themselves and their families, it is their duty to be therewith content. But this is a narrow judgment of the matter in issue. They ought not only to perform their daily tasks faithfully, but be so circumstanced that they will perform them cheerfully. In so far as lies within our power, we ought to remove every just cause of complaint. Every human being should have higher and nobler aspirations than merely to provide food and clothing for the body. This should never content him. The head of a family ought to have time for study, thought, reading, recreation, innocent pleasure; he properly desires to give his children a better education than he had, and furnish them advantages superior to those he himself enjoyed.

"The fact that there is unrest and dissatisfaction when man is confined to unremitting toil, is one of the brightest and most healthy omens of the times. It is an indication that his better nature is struggling for emancipation; it is a hopeful sign of finer and nobler manhood in the future. Such efforts for improvement should never be discouraged, but always encouraged. That there ever have been and ever will be grades of society, is true enough; the statesman should seek to diminish the distance between the extremes by elevating the lower. It has been said that as soon as the materials for the construction of society were brought together they proceeded forthwith to arrange themselves in layers,—the stronger, more nimble and more cunning of the living constituents climbing to the higher places, and forcing upon those below the office of upholding them in their elevation. As the pyramid was originally built, so it remains in its general design. Within the heaving mass of multitudinous life, individual atoms are constantly changing places, but without destroying, however much disturbing, the primitive distribution into layers. These are still disposed, one above the other, in a gradually diminishing series. It is so natural to feel that what always has been must always be, that we are too apt to content ourselves with things as we find them. But this is the dictate neither of wisdom nor of prudence. Standing still is not the province of society; it must either advance or retrograde. Especially, under such a government as ours, is change almost a normal

condition and an inherent necessity. The pyramid continues t lift itself as an entirety; but atoms in the bottom layer of t may be in the top layer of to-morrow. Hence one reason w becomes us to fairly and honestly examine the condition o laboring classes, upon whom the whole superstructure of the s organism rests. Because they are a part of ourselves, it dev upon us to relieve them, as far as possible, from the grievanc which they are subjected. Their existence is not separate fron existence of the State; what tends to their welfare is calculate promote the general welfare; in the last analysis their intere identical with the interest of the upper classes; the least add to their comfort is a gain to the whole community, and if their is considered in the right spirit there is no good cause for an nistic feeling. The question raised by them, and in their behalf never be adjusted by the two extremes,—those anxious to se the greatest possible amount of pay for the least possible work, those anxious to obtain the greatest possible amount of worl the least possible pay. Nor will relief come with the determin how many hours shall constitute a legal day's work. For no p can be fixed which should be applicable alike to all. The inger skilled laborer, who uses mind as well as muscle, cannot a himself the same number of hours to his task as he who m handles the hoe or shovel, holds the plough or drives the oxen, the trowel or weaves at the loom. The great desideratum i determine what would be a fair division of profits between the ployer and the employé. Settle the question as to compens per hour, and there will be no serious difficulty about the numb hours.

"Let us not expect to adjust the issue confronting us by lectu the laboring classes. We must be willing to meet them on own ground, and discuss the matter at stake from their poi view. We must not only believe in the necessity, but have fai the practicability of cultivating the soil. Plough it thorou enrich it as may be necessary, prepare it to the utmost fo abundant crop. However barren it may appear to superficial o vation, it is capable of almost indefinite improvement. I comn to your earnest attention the results which may be wrought ou the Bureau of Statistics of Labor. I doubt not you will welc any and every fact tending to throw light upon the solution of great labor problem. A subject so vital to the Commonwealt the question whether the daily life of a majority of its citizens be enlarged and improved must not be ignored, and should re no secondary consideration at your hands."

The secured legislation is summarized below :—

"Chap. 86, Acts of 1872.—An Act authorizing cities and towns to establish industrial schools.

"Chap. 281, Acts of 1872.—An Act amending the statutes in relation to imprisonment of poor debtors.

"Chap. 318, Acts of 1872.—An Act extending the provisions of the lien law.

"Chap. 348, Acts of 1872.—An Act to secure cheap morning and evening trains on railways for the use of workingmen."

The bureau report in relation to depositors in savings banks provoked much discussion. The matter was referred to the committee on banks and banking, and they reported a Resolve declaring the disbelief of the legislature in the figures given by the bureau. The Resolve was defeated in the House, 69 to 72. A motion was also made in the House to abolish the bureau on the first of September, 1872, but the bureau was sustained, 103 to 71.

The petitions for a ten-hour law were few. A bill was introduced, passed by the House, and rejected by the Senate. The eight-hour petitioners, again, were allowed to withdraw.

Labor Legislation in 1873.

Governor Washburn, in his second address, manifested his belief in the importance of the labor movement by a lengthy consideration of the subject.

"Three annual reports by the Bureau of Statistics of Labor have been laid before the public, and the fourth will be submitted to you in due time. Those who were most instrumental in the creation of this bureau generally admit that it has not fulfilled their expectations. Nearly every branch of the labor movement has openly and decidedly expressed dissatisfaction with its methods and its results, and I am not aware that capitalists and employers have expressed any particular gratification therewith. What course shall be pursued in reference to this department is a question that challenges your careful and thoughtful deliberation.

"While it may be confessed that the investigations of the bureau have not been so thorough and complete as to commend its conclusions to universal assent, it must be borne in mind that its reports contain our only official statements on the subjects of which they treat, and have been printed and circulated by public authority.

seeking information as to the social condition of Massachusetts. They have been cited, and will again be cited, in the debates of Congress upon measures proposed for the protection and enlargement of our industries, as showing how the benefits of such protection are distributed. If they give a false or partial picture of the relations of labor to capital in our Commonwealth, the remedy for complaint on this head must be sought, not in discontinuing the investigation upon which we have entered, but in lifting it to a higher and broader level, making it more thorough, and conducting it with larger aims.

"Whether a laborer can accomplish as much in one hour as he can in two, whether the machinery in a well-managed factory can turn out as many yards of cloth in eight hours as in ten,—these problems the Massachusetts Yankee may safely be left to solve for himself without official aid or prompting. But we ought approximately to know, for instance, how many grown persons there are in the State, not prevented from labor by vice, indolence or physical infirmity, who cannot procure comfortable homes for themselves and their dependents, fair education for their children, adequate provision for sickness and old age, and sufficient leisure for the comprehension and discharge of the duties of citizenship. The incapacity to procure this is poverty. We ought to know whether the proportion of such persons is increasing or diminishing; whether our legislation hastens or can be made to hasten the decrease or counteract the increase. If there is carried on in the State any business so unremunerative that it will not permit the employers to pay those employed such wages as are necessary to keep them from poverty, however desirable that business may be, it ought to cease. And surely we ought to know, if it be possible to ascertain, whether there are really among us employers who are laying up great riches for themselves by keeping their employés in a condition of impoverished dependence.

"In order to secure statistical information on these and other related issues, different instrumentalities from those now in use will be required. A schedule should be carefully prepared by the legislature, with the aid of competent assistance, indicating the facts desired from every city and town in the Commonwealth. In the small towns these facts might be gathered by the assessors; in the larger towns, under the direction and superintendence of the selectmen; and in the cities, by wards, through appointees of the mayor and aldermen. Special returns should also be required from all savings banks and such other institutions as can throw light on the general inquiry. Statistics from a few scattered points or isolated

establishments will not suffice; they must be comprehensive or the conclusions founded on them will be valueless and misleading. There may be objections to the plan thus suggested for solving the difficulty in which we now find ourselves. If your honorable bodies will present a better one, I shall be most happy to join you in its adoption. But in my judgment, neither the well-being of our people nor the good name of our State will permit us to rest in non-action. The relations of capital and labor, of employer and employés,—these are issues that will not down at any man's bidding. The questions are among the gravest and most vital of the time; they cannot be thrust aside; they will be heard; they must be discussed; they justly insist upon a practical answer."

The three matters of legislation following had special reference to the bureau:—

"Chap. 377, Acts of 1873.

"SECT. 5. The salary of the chief of the bureau of statistics on the subject of labor, shall be at the rate of three thousand dollars per annum."

"Chap. 63, Resolves of 1873.—Resolve in relation to the Bureau of Statistics of Labor.

"*Resolved*, That so much of chapter one hundred and two of the resolves of the year eighteen hundred and sixty-nine, as requires the bureau of statistics on the subject of labor to have its headquarters in the state house, is repealed."

"Chap. 66, Resolves of 1873.—Resolve relative to the Bureau of Statistics of Labor.

"*Resolved*, That in addition to the sum of five thousand dollars heretofore appropriated for the purposes of expenses and clerical services of the bureau of statistics of labor, there be allowed and paid out of the treasury the further sum of twenty-five hundred dollars, which sum is hereby appropriated."

An order was also passed directing that the reports of the bureau be numbered and classified among the public documents.

Other secured legislation is comprehended in the succeeding statement.

"Chaps. 262 and 279, Acts of 1873.—Acts to secure the attendance of children at school. (Twenty weeks for children between eight and twelve.)

"Chap. 306, Acts of 1873.—An Act authorizing towns to pay such sums as they see fit towards maintaining public libraries.

"Chap. 6, Resolves of 1873.—A Resolve appropriating fifteen thousand dollars to represent the industries and educational system of the State at the Vienna Exposition."

Labor matters occupied much of the time of the legislature of 1873. A change in the officers of the bureau was called for, and rumors of abolishment seemed likely to end in fact. Thirty-three petitions against abolishment were put in, many praying for increased powers and appropriations. Two memorials against abolishment were received from Pennsylvania, one from the American Statistical Society, and the Society of Internationalists in Boston filed a remonstrance. The officers for the next term of two years were new men, and the vexed question was dropped.

A ten-hour bill for women and children was passed in the House, and rejected by the Senate. Both branches again gave the eight-hour petitioners leave to withdraw.

Labor Legislation in 1874.

Governor Washburn's state papers upon the question of labor had attracted much attention during the past two years, and his address for 1874 gave the subject more prominence than ever. He said, regarding—

"*Labor Reform.*

"The annual report to be presented for your consideration in due season by the Labor Bureau, will indicate what has been done by the present organization during the past six months. Of course no very elaborate investigations can be undertaken and completed in that space of time. But you will have a right to inquire whether an honest endeavor has been made to obtain information that will aid in determining what measures are necessary to elevate and improve the condition of the great mass of laboring men and women in this Commonwealth. The bureau should not be continued, in order to furnish a desired position or coveted salary to this or that individual. When it ceases to collect facts and statistics calculated to assist statesmen in working out the problem of industrial reform, its usefulness will be at an end, and it should be discontinued or radically changed in management. Nor should it be run in order to further some pet scheme of this theorist or that mere enthusiast. Its object should be to deal with statistics, to keep back nothing, to cover up nothing, to present no one-sided picture, but as far as possible

to collect all the facts, and leave them to speak for themselves. And when the investigation is made so broad and comprehensive, that it will be impossible to gainsay the conclusion, I do not doubt that every sensible man will see the necessity for steps to better the situation of the laboring classes.

"A hasty glance at the condition of the children of these classes in many of our large manufacturing communities, is sufficient to convince the most sceptical that important changes are imperatively demanded as soon as they can be brought about. The assumption of our laws is, that the highest intelligence is the highest good of the entire people. Ignorance is dwarfing to the individual, and dangerous to society. It is wiser economy to sustain the common school than the reform school, the normal school than the house of correction, the college than the penitentiary. The State assumes that the physical, mental and moral treasures embraced in what we call childhood, are so much capital belonging to the community as well as to the parents. And it has been well said that the State undertakes to provide for, invest, develop and look after this childhood treasure, in such a way that it shall pay the highest dividends to the Commonwealth. No distinction of outward condition, whether it be of wealth or poverty, of birth or race, can be allowed to interfere with the purpose of the State. She claims the right and responsibility of providing a good common-school education for every child within her borders, at the public expense. She starts them all upon the highway toward useful and honorable manhood and womanhood. That she advances and maintains this theory is one of the crowning honors of our good Commonwealth.

"In the first communication which I had the honor to make to the legislature of the State, I presented figures showing that nearly all our children were attending a school of some sort. But a closer and more thorough investigation reveals a state of things that I did not then suppose existed. I find many thousand children in our crowded cities and manufacturing establishments, who never enter a school-room, and are growing up without even the rudiments of what we call education. The number of this class seems to be increasing yearly, not because of a change for the worse in public sentiment, but because the facts of the case have not been sufficiently well understood in any quarter.

"The blame for the deplorable condition of things that really exists in our manufacturing establishments, is often quite as much with the employés as with the employers. Families frequently move to manufacturing localities for the express purpose of obtaining employment for children. The anxiety of parents to reap the fruits of the constant labor of their children is so great, that they are

quite willing to neglect all provision for their mental or mor ure. I do not doubt the wisdom of the statute which r children between the ages of five and fifteen years to be school, and I know how indispensable pure air and out-do cise are to their health and development, yet there is no inc able number of parents whose necessities seem to compel t seek employment in mills and manufactories for every me their families who is able to work. The struggle for exist such that they cannot stop to inquire whether the impure long confinement of these establishments are conducive to the and vigorous growth of boys and girls.

"Under these circumstances, I am inclined to think that th lish system of half-time is worthy of imitation. If we cou vide that no boy or girl under fifteen years of age should ployed in any mill or manufactory for more than half the tin then make provision that the other half should be spent in and at out-door sports and exercise, we should institute a rich in promise of reform and deserving of fair and imparti

"Though a statute provision fixing the number of hou operatives shall be required to work never has appeared to such vital importance as some consider it, yet I freely adm there is one aspect of the matter which seems to entitle the q of enacting such a statute to careful consideration.

"While as a general proposition it may be desirable to lea ployers and employés free to agree upon prices and hours of yet the State cannot afford to be utterly regardless of the and social well-being of a large class of its citizens for fear terfering with some established custom or some prevailing s That the strength of the operatives in many of our mills is ing exhausted, that they are growing prematurely old, and th are losing the vitality requisite to the healthy enjoyment of opportunity, are facts that no careful and candid observer will Ten hours is the standard of the longest day's work known branch of mechanical industry in this Commonwealth out portion of our large manufacturing corporations. What wo lost to employers, and what would not be gained to emplo adopting the ten-hour system in these establishments?

"Furthermore, the large majority of operatives in many mills are of foreign birth. What is to be done with them? are we to protect ourselves from the ignorance that is ge their misfortune rather than their fault? How are we to e them into unity of aspiration and purpose with native-born cit Shall we work them so many hours a day that they will have n strength, interest nor time for becoming acquainted with ou

tutions and our aims as a people? Or shall we, by shortening their hours of labor, and the establishment of evening schools, if need be, educate them, fit them for the duties of citizenship, and make them a part of ourselves? Unless something of this sort is done, while the census returns may show accumulation and enlargement, there can be no increase of living power. If we are to have in the future a healthful growth of the body politic, all these different elements of population must be blended into one harmonious whole. This will be a work of time and patience, I very well know, but we cannot go on indefinitely without some broader and deeper consideration than we have yet given, as a community, to the well-being of those among us from foreign parts.

"The limit of a day's work to three-fourths of the laboring class in this Commonwealth being ten hours, I am not able to see that any great detriment would result if the same limit should be extended to the other fourth. I have no hesitancy in recommending that the experiment be tried, and you may anticipate executive approval if you enact a ten-hour law. I know of no reason why it should not apply as well to male as to female operatives. Much is said about the importance of elevating labor; but it is difficult to see how this can be done, except as we elevate the laboring man and woman. Make better provision for their instruction, assist them in the development of the higher faculties of their natures, encourage them to secure comfortable homes of their own, and you awaken capabilities that have hitherto slumbered, and give them enlarged hopes and brighter aspirations for the future. Every new homestead will inspire its occupant with new energy. It will bring him to a personal interest in the government of which he is a member, and make of him a stronger and worthier citizen in every respect. Indeed, there is very little worth in a man if the ownership of home does not stimulate him in a thousand honorable and ennobling ways. He who has been actively instrumental in lifting one deserving family into this new sphere, has done better service to the laboring class than the noisy, frothy demagogue will do in a lifetime.

"It is a requirement of the constitution that the census of the State shall be taken in 1875. This affords an opportunity that we ought neither to neglect nor misuse. Along with legislation for giving effect to the census requirement, I hope provision will be made for as searching an inquiry by the Labor Bureau as is practicable, into the social condition of our working classes. An honest and thorough investigation, conducted in a manner to command confidence, would enable us to see ourselves as we really are, much more clearly than we now can, and furnish the data on which to

monwealth."

The following Resolve had particular relation to the bureau work:—

"Chap. 62, Resolves of 1874.—Resolve concerning the Education of children employed in manufacturing establishments.

"*Resolved*, That the bureau of statistics on the subject of labor is directed to prepare a plan for the education of children employed in manufacturing establishments, and report the same to the next general court with the next annual report of said bureau."

Additional labor legislation is given below. The text of the Act in relation to the census and industrial statistics will be found in its proper section in this volume.

"Chap. 221, Acts of 1874.—An Act establishing the hours of labor at sixty per week for women, and children under eighteen years of age.

"SECT. 1. No minor under the age of eighteen years, and no woman over that age, shall be employed in laboring by any person, firm or corporation in any manufacturing establishment in this Commonwealth more than ten hours in any one day, except when it is necessary to make repairs to prevent the stoppage or interruption of the ordinary running of the machinery: *provided, however*, that a different apportionment of the hours of labor may be made for the sole purpose of giving a shorter day's work for one day of the week; but in no case shall the hours of labor exceed sixty per week.

"SECT. 2. Any such person, firm or corporation which wilfully employs any minor or woman, or which wilfully has in its employment any minor or woman contrary to the provisions of this act, and any superintendent, overseer or other agent of any such person, firm or corporation, who wilfully employs any minor or woman in laboring for any such person, firm or corporation, and any parent or guardian of such minor who permits such minor to work or be so employed contrary to the provisions of this act, shall, for each offence, be punished by a fine not exceeding fifty dollars, to be recovered on complaint in any court of competent jurisdiction, and all prosecutions for offences under this act shall be begun within one year from the commission thereof. No building or premises used solely for the purposes of a dwelling shall be deemed a manufacturing establishment within the meaning of this act.

"SECT. 3. This act shall take effect upon the first day of October next.

"Chap. 279, Acts of 1874.—An Act preventing the appearance of children under fifteen as acrobats, contortionists, etc.

"Chap. 386, Acts of 1874.—An Act to provide for taking the industrial statistics and decennial census of the Commonwealth.

"Chap. 393, Acts of 1874.—An Act regulating deposits in savings banks."

As has been indicated, a ten-hour law for women and children was passed, but only after determined and long-continued opposition. The various drafts of the bill were in turn referred to the judiciary committee, the attorney-general, and to a conference committee. Several remonstrances *against* a ten-hour law were presented. At one stage the president of the Senate, by his casting vote, secured the enactment of the bill. The vote, however, was reconsidered, and but for a rule prohibiting amendments of engrossed bills, would have been amended; as it was, it was recommitted. The final vote in the Senate was 21 to 11. The only yea and nay vote of the House, in the early stages of the bill, was 111 to 19. But for the election of Governor Washburn to the United States Senate, his name would have appeared officially upon the law.

Labor Legislation of 1875.

Governor Gaston, in his address, thus referred to labor matters:—

"I earnestly commend to your careful consideration this great subject of skilled labor. It is of vital interest to a manufacturing people, and I trust that your fostering care of it will be apparent in such legislation as may promote the welfare and renown of our Commonwealth and country. The Act of 1867, chapter 285, provides that no child under the age of ten years shall be employed in any manufacturing or mechanical establishment, and no child between the ages of ten and fifteen years shall be so employed, unless he has attended school for three months in the year next preceding such employment, nor unless he shall attend school at least three months in each year during the continuance of such employment.

"The Act of 1874, chapter 221, provides that no minor under the age of eighteen years, and no woman over that age, shall be employed in any manufacturing establishment more than ten hours in any one day, or sixty hours in any week.

"These two Acts affect deeply the welfare of the Commonwealth. They both have my cordial approval. To carry out the spirit of such legislation, the education of the operatives in Massachusetts should receive the thoughtful consideration of the legislature. For persons so employed, half-time schools, which have been introduced

with great success into both the manufacturing and agri districts of Great Britain, seem to me the best expedien problem has already been presented,—whether in a public instruction in practical pursuits which may enable, or assis abling, the pupil to earn a livelihood in early years, shoul joined with the customary tuition. In manufacturing comm this form of instruction cannot be properly or safely ne The necessities of the pupil and the public interests alike that those whose inheritance is that of labor, shall have t time and opportunity for instruction, and for a kind of ins which shall give to labor intelligence, and consequently in value and compensation. Half-time schools have, in som divided the hours of the day between instruction and labor have taken entire days for each; while others, again, preser alternations, have taken entire periods, consisting of several for each. The selection between these plans may be influe the kind of industry in which persons are engaged. As a rule, the evidence of experience is in favor of the division day. It is shown by those engaged in instruction, that h scholars, as a rule, are quite equal in average attainments t who have full school hours without the alternations of work.

"A Resolve of 1874, chapter 62, directs the Labor Bu prepare a plan for the education of the children employed in facturing establishments, and report the same to this court. I commend the whole subject to your thoughtful co tion. That system which shall give to labor the time and o nity for education and culture, will never injure the moral o rial interests of a people, or withdraw from wealth or capital its rightful possessions."

Other legislation relating to labor or the bureau w hereinafter summarized. The text of the Act and I relating to the census and industrial statistics will be fo the proper section of this volume.

"Chap. 93, Acts of 1875.—An Act respecting the takin decennial census in Boston and other cities.

"Chap. 211, Acts of 1875.—An Act to regulate special co for labor.

"SECT. 1. Any manufacturing establishment which shall require employé a notice of intention to leave the employment of such establ under penalty of forfeiture of any part of wages earned, shall be the payment of a like forfeiture if they shall discharge an employé notice, except for incapacity or misconduct: *provided, however,* that

shall not apply in case of a general suspension of labor in said establishments.

"SECT. 2. Whoever shall, by intimidation or force, prevent, or seek to prevent, any other person or persons from entering or continuing in the employment of any corporation, company or individual, shall be punished therefor by a fine not exceeding one hundred dollars.

"SECT. 3. This act shall take effect upon its passage.

"Chap. 37, Resolves of 1875.—Resolve providing compensation for taking the census and industrial statistics.

"Chap. 71, Resolves of 1875.—Resolve appropriating fifty thousand dollars to represent the arts, institutions and industries of the Commonwealth at the Centennial Exhibition at Philadelphia."

The ten-hour agitation had not been quieted entirely by the passage of the law of 1874. Several petitions were presented praying for a modification of the law. Others remonstrated against the repeal of any of its provisions. Both branches granted leave for petitioners to withdraw.

Although the bureau, acting under the law of 1874, had prepared the schedule of inquiries for the census and industrial statistics, had appointed enumerators, and had its special work under full headway, a motion was made to abolish the bureau, and turn its work over to the secretary of the Commonwealth. This ill-advised proposition, if successful, would have necessitated a great waste of time and money, and undoubtedly would have destroyed the comprehensiveness of the work, for the secretary would have either been obliged to follow blindly the plans of others, or arrange his own in a very limited time. The friends of the bureau rallied with petitions and remonstrances; the uselessness of the change was clearly shown at hearings and by the press; the House vote sustaining the bureau was decisive, 134 to 36.

Reference has been made to the reports of General H. K. Oliver, when special state constable, to enforce the school law for children in manufactories. After his appointment to another official position, another constable was detailed, in August, 1869, but he made no report of progress. The police commission of 1871 gave general instructions to constables to enforce the law, but warned them against incurring any expense unless possessing positive information, thus rendering the law a dead-letter, practically. Upon the abolish-

ment of the police commission, a chief constable was a| ed, and he, August 8, 1874, detailed George E. M Esq., of Cambridge, to carry into execution the laws r to working children.

His report was made to the governor, January 11 (Senate Document, No. 50). Like the reports of Gen. it was devoted to comments upon the weakness of the la impossibility of one man performing the work, and p suggestions of needed legislation. He recommended t school age be changed from five to fifteen to five to eig although he stated his belief that 60,000 children fr to fifteen were growing up in ignorance, without any sch whatever. Mr. McNeill also recommended registratio children of school age, the English factory system in minutiæ, the English half-time school system, and an ins with three deputies to enforce the above-named laws passed. The bureau reported in March, as required legislature of 1874, upon the subject of half-time school ing strong ground against their establishment in this Speaking of the education and employment of young pe the report says:—

"Personally, we believe in the extremest legislation in thi tion, and could we have the power given us, we would not girl under sixteen years of age to be employed in any kind of tory or workshop. If she could be free until she reached the twenty, mankind would be the gainer."

The argument against the establishment of half-time s thus concludes:—

"In the statements which follow we have summarized ou points of belief in the whole matter, and our reasons therefo the recommendations annexed we believe to be expedient as wise; and that they will tend to lay a *permanent* foundation f future welfare.

"We believe that, generally speaking, the period of chil and youth should be a period of free and unrestricted ph growth, that the bodily man and womanhood may be vi and vital. We believe that this is peculiarly essential i country, where life is so intense, and so many accomplishmen crowded into every year of adult life.

"We believe, also, that the period of childhood and youth should be a period of mental and moral discipline and education, that the adult may not have to contend blindly and at great disadvantage with the forces of nature, and be subject constantly to the depredations of his fellow-men.

"We believe, in short, that children should have no legal status as workers, but only as pupils; and, above all, that the poverty of parents should not be allowed to foster the one condition or frustrate the other, inasmuch as it is unwise for the State to permit the future usefulness of its citizens to be jeopardized by causes within its control.

"We believe that the opportunities for education should be the same for *all* the children in the State; and that a special and necessarily poorer class of schools should not be established for the children of the poor. We believe this, because it would be a direct blow at the democratic foundations on which our governmental structure rests.

"And in answer to the Resolve of the legislature, we would recommend that our laws be so revised as to provide compulsorily for the attendance of all children between the ages of five and fifteen (not in attendance upon any private school) in the public schools for as long a time each year as they are kept in operation. And for the general accomplishment of this, that the state or local authorities be required to investigate and relieve, to such extent as is necessary, all cases of absolute and unavoidable individual poverty, which would otherwise prevent compliance with this obligation."

The report continued,—

"We present below the outline of a bill which we would offer as our conception of the proper 'plan' to be adopted.

"If any consider it impracticable, we have only to say that it does not go as far as the laws of some European countries, and seems to us absolutely necessary, if we expect to bring Massachusetts up to the same plane of nearly universal education which they occupy.

"SECT. 1. On and after the first day of September next, no child under the age of twelve years shall be employed in any factory, workshop or establishment where the manufacture or sale of any species of goods whatsoever is carried on; and after the first day of September, eighteen hundred and seventy-six, no child under the age of thirteen years shall be so employed; and after the first day of September, eighteen hundred and seventy-seven, no child under the age of fourteen years shall be so employed; and

after the first day of September, eighteen hundred and seventy-eight, ı under the age of fifteen years shall be so employed: *provided*, that c of the age of twelve years, and under the age of fifteen years, may ployed until the first day of September, eighteen hundred and s eight, during such times as the schools of their respective towns (are not in operation, or for a certain portion of each year, until the af first day of September, eighteen hundred and seventy-eight, as perm the following section.

"SECT. 2. No child of the age of twelve years, or who has not ı the age of fifteen years, shall be employed in any factory, works establishment where the manufacture or sale of any species of good soever is carried on, unless, within the twelve months immediately pr the beginning of such employment, and during each succeeding pe twelve months of such employment, such child shall have attenc public day schools of the town or city wherein his parents or gu reside, for at least twenty weeks of five days in a week, which time divided into two terms, each of ten consecutive weeks, so far arrangements of school terms will allow, or for forty weeks of five ha in a week so divided: *provided*, that attendance for the same number or half-days, consecutively, upon any private school approved by the board, shall be considered an equivalent; and no manufacturer, m or other employer shall employ any child unless such child shall ha sented a certificate, signed by the superintendent of schools, or school board, certifying that such child has complied with the requi of this act.

"This section shall be construed to render permissible the employı children of the ages named, only until September first, eighteen h and seventy-eight, and shall be null and void on and after that date.

"SECT. 3. It shall be the duty of the truant officers, in all cases poverty apparently prevents the attendance at school of any child, tc the same, within ten days after the beginning of each term, to the ov of the poor, who shall, within ten days thereafter, if, on investiga sufficient degree of poverty be clearly apparent, provide, at the exp the town or city, relief from such poverty to the extent necessary to the attendance of such child at school.

"All truant officers and boards of overseers of the poor who fail to with this section shall be subject to a fine of not more than and not less than dollars, in the case of each child; anc manufacturer, merchant or employer, who employs any child cont the provisions of this act, and every parent or guardian who permi employment, shall be subject to a fine of not more than doll not less than dollars, in the case of each child. Justices of or district courts, trial justices, trial justices of juvenile offenders and of probate shall have jurisdiction within their respective counties offences described in this act.

"SECT. 4. All fines collected under this act shall accrue to the be the school fund of the town or city."

The bureau took ground, also, against the introducti the ponderous factory system of England into Massach but suggested the outline of a—

"*Factory Act.*

"The belting, exposed shafting, gearing and drums of all manufacturing establishments shall be securely guarded.

"No machinery, other than steam-engines, in any such establishment shall be cleaned while running.

"Elevators in all such establishments shall be supplied with well-protected safety-catches and self-closing hatches.

"For every one hundred feet, ends and sides of such establishments, and to each story, there shall be on the outside a fenced platform, each platform to be connected with the one above it by a slanting ladder guarded by rails, and with the interior by windows or doors.

"For every twenty persons employed there shall be one rope, or portable fire-escape. All outside doors shall open outwardly or slide.

"Each story shall be supplied with apparatus for extinguishing fires,—water-buckets, flooding hose or pipes, hydrants, etc.

"All male operatives shall be organized into fire-parties, and trained to the use of the fire apparatus of the establishment.

"No person shall be constantly employed in the attic rooms of such establishments, unless such rooms are thoroughly protected by suitable fire-escapes, as herein provided; 'story' shall comprehend 'attic.'

"It shall be the duty of employers to see that rooms are amply ventilated and kept clean; that water-closets are thoroughly cared for, and that noxious odors are deodorized.

"No married woman shall be employed in any such establishment for at least two months subsequent to the period of confinement; and on returning to work shall, to this end, present a physician's certificate to her employer.

"Any person violating any of the provisions of this act shall forfeit for every such offence not less than twenty nor more than one hundred dollars.

"For the purpose of carrying into effect the provisions of this act, the governor, by and with the consent of the council, shall, on the passage of this act, and thereafter, biennially, in January, appoint a suitable person having practical knowledge of sanitary matters and of mechanics as chief inspector of factories; and such chief inspector shall appoint not less than three nor more than seven deputy inspectors. The salary of the chief inspector shall be $3,000, and that of his deputies $2,000.

"The duties of the chief inspector shall be to enforce the provisions of this act, and of any acts relating to the employment and

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to be engrossed. The Resolve for abolishment found little favor in the Senate, it being rejected by a vote of 26 to 4.

The secured legislation, to date, is found below:—

[Chap. 52, Acts of 1876.]

"AN ACT relating to the Employment of Children, and regulations respecting them.

"SECT. 1. No child under the age of ten years shall be employed in any manufacturing, mechanical or mercantile establishment in this Commonwealth, and any parent or guardian who permits such employment, shall for such offence forfeit a sum of not less than twenty nor more than fifty dollars, for the use of the public schools of the city or town.

"SECT. 2. No child under the age of fourteen years shall be so employed, unless during the year next preceding such employment he has attended some public or private day school, under teachers approved by the school committee of the place where such school is kept, at least twenty weeks, which time may be divided into two terms, each of ten consecutive weeks, so far as the arrangements of school terms will allow; nor shall such employment continue, unless such child shall attend school as herein provided, in each and every year; and no child shall be so employed who does not present a certificate, made by or under the direction of said school committee, of his compliance with the requirements of this act: *provided, however*, that a regular attendance during the continuance of such employment in any school known as a half-time day school, or an attendance in any public or private day school, twenty weeks, as above stated, may be accepted by said school committee as a substitute for the attendance herein required.

"SECT. 3. Every owner, superintendent or overseer in any establishment above named, who employs or permits to be employed, any child in violation of the second section of this act, and every parent or guardian who permits such employment, shall for such offence forfeit a sum not less than twenty nor more than fifty dollars for the use of the public schools of such city or town.

"SECT. 4. The truant officers shall, at least once in every school term, and as often as the school committee require, visit the establishments described by this act in their several cities and towns, and inquire into the situation of the children employed therein, ascertain whether the provisions of this act are duly observed, and report all violations to the school committee.

"SECT. 5. All acts and parts of acts inconsistent with the provisions of this act are hereby repealed."

Chapter 142, Acts of 1876, incorporates the Massachusetts Family Bank, upon insurance principles earnestly advocated by Elizur Wright, Esq., and others. Of the pending bills, one regulates the rate of interest in savings banks, while a second provides that the chief of the State detective force shall detail one, but no more than three deputies, to exercise a supervision over manufactories and buildings, and enforce the provisions of the school laws for working children. The bill, however, provides that such duties shall cease January 1, 1877.

VII.—Foreign Labor Legislation.

We do not propose, under the above heading, to give a minute history of labor and labor legislation in England and other European countries; only to show the most salient points of progress. Labor, in the abstract, has no country; it is the life of all countries. Between the English speaking peoples there is, however, more of a unity of interests; a comparative humanity exists, even if not acknowledged. If Massachusetts or America had led in labor reform, England would have watched our progress as intently as we watch here. We cannot separate the countries upon the labor question any more than we can as regards literature, science or that Saxon endurance which surpasses simple bravery. In the section of this volume which states the results of the seven years' investigations of the bureau, much information concerning the labor legislation of foreign countries is given. The following brief statement of the causes which led to the English Factory Acts is copied from an article by Mr. C. L. Brace in "Harper's Magazine" for August, 1873.

"At length a band of devoted reformers and philanthropists arose, who were determined that this burning shame of their country (uneducated and overworked child labor) should be wiped out; who felt that the wealth and culture of England rested on a hideous foundation, when the labor of oppressed children built up the structure. They began an incessant agitation against the over-labor of factory children. They wrote for the press, printed documents, held public meetings, petitioned parliament, and sought in every way to rouse the public feeling and conscience. . . .

"After incessant discussion, and a long contest, the English 'Fac-

tory Bills' were carried through parliament, were repeatedly amended, improved and enlarged until they form now a ponderous blue-book. These Acts have been rigorously executed, and their effect has been that hundreds of thousands of little 'white slaves' have been redeemed from slavery, saved from premature death and sickness, and that a new class of English laborers is growing up, better educated, healthier, happier, and of more value to their employers. The reform was one of the most glorious and beneficent ever carried out in Great Britain."

Besides Great Britain, other European countries have laws for the protection of children. Prussia, France, Switzerland and Italy provide for the education of working children; Portugal, Russia and Austria are remodelling their school systems; compulsory education is the rule in Belgium, Norway, Sweden and even Turkey.

From 1833 to 1868, a period of thirty-six years, *two hundred and eighteen* special reports upon subjects connected with labor legislation were made by English parliamentary committees, an average of *six* yearly. These reports, valuable as they are, are scattered, and there is no one department of the English government to which application can be made for statistics. In Prussia, France, Saxony, Switzerland, Holland, Belgium, Bavaria and Russia there are central statistical bureaus, under the charge of competent men, from which official information is easily obtainable. In the section of this volume headed "Opinions of the Public and the Press," the names of the directors of many of these foreign bureaus are given with their addresses. Mr. George Howell, late secretary to the English parliamentary committee on trades-unions, who has given long and valued service in that capacity,—and of whom it is said "his great industry, patience, clear-headedness, and, above all, his moderation and most conciliatory manners, have immensely contributed to the unravelling of many difficulties, and to the promotion of a common understanding between parties opposed (or apparently opposed) to each other,"—makes the following suggestion in an English periodical called "The Beehive," of date February 12, 1876, for the establishment of an—

"English Bureau of Statistics of Labor.

"The vast and daily increasing importance of all movemen nected with, or having reference to, labor in this count especially the legislative tendency of very many of these ments, point conclusively to the necessity of a bureau of st of labor where the statesman, philanthropist, author, journ citizen can at all times, obtain authentic information and statistics, when attempting to deal with some of the many pr connected therewith.

"Political economy is still a progressive science; many teachings of its most able exponents have to be narrowly s and tested by the light of facts drawn from every-day life. ever any subject of especial interest comes up for discussion, ing broad and comprehensive treatment on the part of the p economist or statesman who attempts to deal with it, he must the machinery necessary to get the information absolutely r for its elucidation.

"Valuable sources of information and much useful and data exist, but these have to be sought out and the facts t together, assorted and tabulated, before they can be ready for diate use. This is often done at great cost both by private i uals and by government, but the misfortune is that the v collections of facts so obtained by men of extensive experien general knowledge are often lost because there is no per record kept of them, and no office where they could be exami obtained for future use.

"Such a permanent record could be prepared and maintai much less expense than is now incurred for merely the specia of passing interest which are sometimes needed by the gove or by private members of the House of Commons.

"It seems almost incredible that an old industrial coun Great Britain should be without a bureau of statistics of In America, bureaus are established in Washington, Massach Connecticut, Pennsylvania, etc., and judging by the valuable i ation annually issued, these departments give good satis not only to employers and workmen, but also to the general whose interest after all is of the first importance in all qu affecting labor and the condition of workmen.

"There are very many subjects which would naturally come the scope of such a department, upon which reliable infor should be obtained. These inquiries and reports should alt avoid any controversial treatment of the several matters rel to the department, its object being to furnish correct data,

would be valuable to all classes and all parties, and be tabulated for ready and immediate use.

"Recent legislation seems to me to render such a department absolutely essential. The special subjects for inquiry, amongst others, are the following:—

"1. Divisions of labor, primary, secondary and otherwise; general effect of such division of labor upon the special trade, upon prices and upon the open market.

"2. The price paid for labor, variations according to locality or other circumstances, whether it includes partial cost of materials, use of machinery, light, fuel, tools, implements or other matters.

"3. Hours of labor, variations according to locality, overtime and other matters relating thereto.

"4. Terms of labor, whether day-work or piece-work, nature of contracts, terms of engagement, whether by the day, week, month, etc.

"5. General effect of such contracts, relative influence on employers and workmen, and on the labor market.

"6. Labor organizations, their nature and extent, number of members in the several unions, their proportion to non-members, the principles upon which they are conducted, their payments, funds, benefits and management.

"7. General state of the labor market, whether overstocked or a scarcity of hands, cause in either case; whether local or general, and whether there are openings for more workmen, and a necessity for the migration of workers from one locality to another.

"8. Cost of living, proportionate cost compared with wages for any given number of years. Have wages increased in the same proportion as the cost of living? Variations in different localities.

"9. Habitations and rents. Description of houses and tenements, rent paid, nature and extent of accommodation, condition of dwellings, sanitary and otherwise.

"10. Proportion of artisans and other industrial classes generally to other classes, nature of distinctions, relative distinctions amongst the working classes.

"11. Strikes, history of, cause of dispute and how settled. Number of persons engaged in the strike, and their families, cost of the strike, how provided, and the general effects of the strike on the locality.

"12. Arbitration or conciliation, how far accepted by employers and workmen; whether any, and if any, what attempts were made to settle the dispute, and by what means.

"13. Co-operation. What co-operative societies or stores exist in

erative productive societies. State number of members, summaries of business done, and profits.

"14. Benefit societies. Number and nature of, number of members, benefits, contribution, how conducted, whether annual or permanent.

"15. Building societies. Number of members, value of shares, shares issued, interest paid on capital; number of advances made, mode of repayment, amount of interest charged per £100, how conducted.

"16. Savings banks. Deposits therein, or in loan societies, or other similar societies. Interest paid on capital, interest charged on loans, nature of such societies and general management.

"17. General condition and position of the industrial classes in the several counties, or in special districts.

"18. Abstracts of legislative measures affecting these classes, either sought for or obtained, with special reference to statutes previously passed.

"These and similar subjects would come within the scope of such a department, and we believe that a great variety of useful information would be obtained of permanent interest to all classes; carefully prepared tables should be given according to the importance of the subject-matter, and where other government returns supply the necessary information, the needful reference should be given to save the time of the inquirer. It would also be useful to indicate other special sources of information where they exist, or to give abstracts of documents or books, if of sufficient importance.

"It might be objected that we already possess some of the information sought in the report of the board of trade, and of the registrar of friendly societies. This is, to some extent, true, but it is insufficient and dispersed; we want it to be exact, full, complete and compact. Workmen may object that it may furnish too much information for their benefit. We reply, not so, for it is obtainable now, and its inexactitude is a far greater evil than the fullest knowledge can possibly be. Moreover, it is very undesirable that there should be any semblance of secrecy in any organization or movement, and all investigations regarding labor, commerce or trade, and of the whole condition of industrial and social life, as well as its educational, sanitary and political character, should be open to all, and conducted in the light of day."

A reference to the section of this volume, which gives the results of the bureau investigations, will show the reader that

the work of the Massachusetts Bureau of Statistics of Labor has been nearly identical with that laid out above, and makes manifest that in this one element of labor reform, at least, Massachusetts has led England, and shown to the thinking labor men of that country, that in the universal work of labor reform this bureau is doing no inconsiderable service. The Bureau of Statistics at Berlin, Prussia, is closely allied to this department in its manner of working, and the figures obtained therefrom have been of great comparative value. Reliable statistics must precede efficient legislation, and we trust before many years that statistical bureaus in the various States of the Union and foreign countries will interchange the fruits of their researches, and aid in securing legislation for the good of labor throughout the world.

VIII.—Organization and Manner of Working.

The Act establishing the Bureau of Statistics of Labor, as has been previously stated, was passed June 22, 1869. The next day it received the governor's approval, and became a law. On the 31st of July, Governor Claflin appointed Hon. Henry K. Oliver of Salem, as chief, who, on the 4th of August, selected George E. McNeill, Esq., of Cambridge, as his deputy. In May, 1871, Governor Claflin, being still in office, re-appointed Mr. Oliver, and he again chose Mr. McNeill as his deputy.

In May, 1873, Governor Washburn commissioned Hon. Carroll D. Wright, of Reading, as chief. Mr. Wright was re-commissioned in May, 1875, for a second term of two years, by Governor Gaston. Upon his first appointment, Mr. Wright selected Major George H. Long, of Charlestown, as his deputy, and he retained the position until appointed deputy insurance commissioner of the State in April, 1876. In that month a bill was passed authorizing the chief to appoint a chief clerk in place of a deputy, and under this bill Mr. Charles F. Pidgin, of Boston, was selected for that position. The assistants employed by the bureau have varied in number each year; ranging from the ordinary force of two or three to as great a number as sixty-five, the latter being required for the tabulation and preparing for press of the census and industrial statistics returns.

house, but in June, 1873, it was removed to a building leased by the State at 33 Pemberton Square, where it now remains.

The salary of the chief was first placed at $2,500 per annum; it was increased to $3,000 in 1873, and reduced to $2,500 again in 1876. The reduction was made in accordance with a general system of reduction of salaries of state officials instituted by the legislature of 1876. The salary of the deputy has been, uniformly, $2,000 yearly. The pay of assistants, in whatever capacity, being limited by law to $4 per day, the highest compensation for clerks and travelling agents has been $1,200 per year. The chief clerk will receive a yearly salary of $1,500. The average expense for each year has been $10,500, one-half for salaries of officers, and one-half for clerk hire, travelling expenses, printing of schedules or blanks, and the usual contingent expenses of such an office. The rent of the rooms occupied is paid by the State out of a general appropriation, and the printing and binding of reports charged to the legislative printing account.

Having shown the personal organization of the bureau, we will proceed to give a brief description of its—

Manner of Working.

The officers appointed in 1869 found themselves in an untried field. To be sure, certain legislative committees and two commissions on hours of labor had investigated somewhat into questions of labor; but here was a new department, with the double duty imposed upon it of choosing its work and then performing it. It will be seen, one of two courses became necessary; either to gather facts indiscriminately, and upon them, if possible, base conclusions, or to start with the belief that certain things were true, and obtain all the corroborative testimony possible.

One of the first acts of the bureau was to send a letter to Hon. J. Lothrop Motley, then United States minister to England, requesting a catalogue of English public documents relating to the general question of labor. He complied with a list comprehending some eighty-six different works, and aggregating about three hundred volumes. Over one hundred

works upon subjects related to labor and the laboring classes were found in the state library in 1869, and the number has been increased yearly. An annual appropriation is made for the state library, and any book desired by a department is secured, and its use allowed.

Besides these sources, the bureau has received since its organization, the reports of the national and of other state governments upon subjects related to its work. Friends have contributed documents, foreign statistical societies have exchanged reports, and files of English labor papers have been kept up. On the other hand, the bureau reports have been sent free to every citizen of Massachusetts requesting the same, and information supplied to the press and general public in numberless instances. The reports have also been sent to all parts of the country, to Europe, and even to Australia; in addition, inquiries by letter from foreign countries have been answered, and all possible information sent. Englishmen and the English government have shown an especial interest in the bureau work, and, as a rule, all pay for documents sent us has been refused. One labor paper, published at London, Eng., has been received regularly for many years, and the publisher insists upon sending it free.

After this statement of certain workings of the bureau, let us return to the remarks of the officers relative to the preliminary investigations in 1869.

In the first report the officers say, referring to the Resolve creating the bureau:—

"The immediate impression derived from the mere words of the Resolve was, that the leading duty of the bureau was the gathering of statistics of labor, and of reporting them to the legislature, together with what might be ascertained of their influence upon the health, education, manners of life and industrial habits of those whose daily labor earns their daily bread, but who, it is not to be ignored, are, as a rule, very inconsiderable sharers in the wealth they help to generate.

"This impression finally enlarged itself, however, into a more comprehensive thought, that it was our duty to inquire into the very important subjects of the hours of labor, the wages, the savings, the manner of life at home and from home, the recreations, the culture, moral and mental, of the laborers, and the influence of the

ignoring the subjects of co-operation, strikes, trades-unions, and the general relations of capital and labor, with such matter relating to the history of labor and labor legislation, here and abroad, as we might be able to gather; so that the actual status, as far as the researches of a few months would permit us to do, of the laboring men, women and children of Massachusetts might be ascertained, and be set forth to the legislature and people of the State."

Certain legal points required consultation with the attorney-general. His replies to various letters of inquiry may be summarized briefly.

1. The bureau has no power, as such, to administer an oath. (This difficulty was overcome by commissioning the chief as justice of the peace.)

2. The bureau has no authority to take depositions. It may send for persons and papers, but has no power to compel attendance.

3. It may examine witness, under oath, but can pay only $1.25 per day as fees, and four cents per mile to and from the office.

With its powers, or rather want of power, thus defined, the bureau began its work, acknowledging its entire dependence upon the voluntary written or verbal testimony of individuals, and upon the investigations of its agents who, in turn, could not compel the unwilling to testify or supply statistics. In the fourth report the officers remark:—

"We are pleased to say that in only one instance has our summons been refused, though in many cases we have been frankly told that as there was no law compelling answers to our questions, they (the respondents) respectfully decline to comply with our request."

The voluntary circular plan was first instituted. Out of 334 assessors, all but 10 replied to a circular sent them asking for information concerning manufacturing establishments in their respective towns. The manufacturers themselves were not so communicative. Only 217 out of 1,248 replied at all, and the answers were, the report says, "generally curt and unsatisfactory." The schedule contained *eighty-one* inquiries. Neither did the workingmen themselves comply generally with the request for information. Their schedule contained

one hundred and thirty-seven questions, and 114 out of 268 replied wholly or in part. The nature of the work for the seven months ending March 1, 1869, is thus explained, and the contents of the first report shown :—

"A much condensed summary of labor in England, and legislation thereon, up to the emigration and settlement of America, supplied by English authorities, occupied about 48 pages. Of the remaining 375, all but eight are occupied wholly by home matter, excluding all foreign matter and statistics. Four of these eight relate to the sanitary influence of factory life abroad, and four to the homes and home-life of French operatives; leaving 367 devoted to labor matters in Massachusetts."

As a preliminary to the work upon the report issued in 1871, correspondence was entered into with officials of other state governments, and with the United States Department of the Interior. The results of this system of preparation were a series of ten blanks. Of these schedules of inquiry, principally addressed to employers, 3,958 were sent out, and 2,447 returned, or 62 per cent. Some of the workmen's blanks used in 1869 being on hand, use was also made of them. Two agents were despatched to the western part of the State to gather workingmen's statistics, and a competent lady detailed to investigate woman's work and the condition of working women. Eight "strikes" occurred in the State in 1870,—at Fall River, Lynn, North Adams, Worcester, Marlborough, Weymouth, Randolph and Needham; witnesses were summoned by the bureau, and their testimony phonographically reported. Letters were sent to prominent physicians, and opinions asked concerning certain deleterious branches of labor. A tour of inspection was made of Boston tenement-houses; workingmen were requested to visit the bureau and make statements of their experience; and a copious selection was made from foreign labor laws and English testimony upon the half-time system of schooling.

The material for the report of 1872 was obtained in a similar manner to that of its predecessors. Statistical information was requested by sending out blank circulars, and depending upon the voluntary courtesy of correspondents. Of 5,112 blanks mailed, 2,161 were returned with replies,

being 42+ per cent. In addition, thirty manufacturing establishments were visited by the officers of the bureau. The officers were aware of the "limited amount of completeness" of the returns, ascribing their meagreness to the small amount of money placed at the disposal of the bureau.

The investigations, though not securing completeness on any one point, were directed to a multitude of subjects, which are thus summarized in the report itself:—

"The subjects to which, during the past year, we directed our attention, were the condition of wage laborers, both men and women, their wages, earnings, hours of labor, cost of living, savings, education, moral and physical status, their opportunities for improvement through unions of any variety, co-operative experiments, libraries, reading-rooms, or other intellectual associations, etc., the surroundings of congregated and out-of-door labor, the conveniences or inconveniences of their working places and homes, and the employment and schooling of children in factories, stores, shops, or on the street.

"Attention has also been given to the influence of different occupations upon health and morals; to strikes, their causes and results; to the truck system; to factory life, here and in England; the story of workingmen's lives by themselves, their arguments upon hours of labor, poverty, etc., and to the experiment with Chinese laborers. Upon this latter subject, the reticence of the employer circumscribes the information within very narrow limits. To this has been added a brief history of the purchasing power of wages in England from the year 1300, and in Massachusetts from its settlement, with comments upon the same, recommendations, and an appendix containing a brief description of labor abroad, and the English truck system.

"The following matters relating to the employments and condition of working-women were specially assigned to a female assistant for investigation; viz., the number of occupations in which they are engaged; their hours of labor, home life, regularity of employment, number of weeks of work during a year, comparative intelligence, examination of their boarding-houses, amusements, health of their special occupations, etc.; disabilities of each class of women-workers as compared with men at the same occupation; merit or demerit of institutions for women, such as homes or lodging-houses; free intelligence offices; advertisements for working women; frauds of the same other than those practised upon men,

guerilla merchants, so called; Jews' shops, sewing-machine frauds, etc.

"From the United States census of 1870, the bureau has prepared a complete index of all the employments in Massachusetts, and has so arranged the details as to give at a glance the number of persons employed, the average wages, yearly earnings, amount of capital invested, and the total product of each branch of industry in the Commonwealth."

In the report for 1873, the officers made a brief allusion to the opposition the bureau had encountered since its existence, and attributed much of it to ignorance of facts. To all attacks, the officers say they never made public reply. Referring to the year's work, the report says:—

"We entered upon the work of the fourth report with the purpose of ascertaining and presenting the facts relating to the actual average annual earnings of all persons employed in the mechanical and manufacturing industries of the State, the wages and earnings and condition of unskilled laborers, the cost of living, the distribution of wealth as shown in the ownership of real and personal estates, and in the deposits in our savings banks; also the effect upon wages and production, of the reduction of the hours of labor from twelve to eleven, the effect of special employments upon the health, morals and prosperity of the people; co-operation, its successes, failures and dangers; the condition of tenement-houses, the condition of labor in the early part of the century, etc."

The tables relating to wages, earnings and days employed, were drawn from the United States census. The personal visits made were chiefly to obtain information concerning the non-enforcement of the school laws for working children. The investigation into co-operative experiments, both by circulars and witnesses, was unproductive. The subject of savings banks received the principal attention of the bureau.

The report for 1874 was the work of the new officers, appointed in 1873, six months having been used in its preparation.

In the introduction the officers state that the following letter, received from a distinguished statistician of the United States, formed a guide in conducting their investigations:—

you do me the honor to ask me my views as to the work of the Massachusetts Bureau of Statistics of Labor; but as the result, I find little to say beyond expressing my hearty sympathy with the purposes of your office, and my wishes for its success. I feel the strongest confidence that the Commonwealth is prepared for your work, and that the work can be done to the satisfaction of all citizens; and that your office has only to prove itself superior alike to partisan dictation and to the seductions of theory, in order to command the cordial support of the press and of the body of citizens. If any mistake is more likely than others to be committed in such a critical position, it is to undertake to recognize both parties as parties, and to award so much in due turn to each. This course almost inevitably leads to jealousy and dissatisfaction. If an office is strong enough simply to consider the body of citizens, and to refuse to recognize or entertain consideration of parties, success is already in the main assured. Public confidence once given, the choice of agencies, the selection of inquiries to be propounded, are easy and plain. The country is hungry for information; everything of a statistical character, or even of a statistical appearance, is taken up with an eagerness that is almost pathetic; the community have not yet learned to be half skeptical and critical enough in respect to such statements. All this is favorable to such laudable efforts as you are engaged in, for the difficulty of collecting statistics in a new country requires much indulgence; and I have strong hopes that you will so distinctly and decisively disconnect the Massachusetts Bureau of Statistics of Labor from politics,—from dependence on organizations, whether of workingmen or of employers, and from the support of economical theories, individual views or class interests,—as to command the moral support of the whole body of citizens, and receive the co-operation of all men of all occupations and of all degrees, without reference, however, either to their degrees or their occupations."

The voluntary schedule plan was deemed worthless in the outset, and was sparingly used. That little use, however, demonstrated clearly the futility of trying to obtain full and credible statistics by such a means. Of the 342 school boards addressed, 206 replied, but of the answers very few were definite in their statements. A schedule of simple, easily answered inquiries was sent to 1,530 clergymen, who were deemed for many reasons "better qualified to answer official inquiries than men in almost any other position in life," and yet

only 544, or 35+ per cent, answered. Some so far forgot the courtesies of letter-writing as to anonymously assert that the information desired was none of the bureau's business. Nine cities and towns were visited, and the sanitary condition of workingmen's homes looked into. Agents of the bureau visited 233 textile manufactories in the State, and made sworn returns as regarded means of escape in case of fire, protection of shafting, guarding of machinery, care of elevators, cleaning of machinery when running, ventilation and average air-space supplied for operatives. From information obtained personally by Hon. Edward Young, chief of the United States Bureau of Statistics, while in Europe, very full tables of rates of wages, hours of labor, prices of provisions, clothing, rent, etc., were prepared. The figures for Massachusetts were gathered by the bureau's agents. From the comparisons instituted, the relative purchase-power of money in Europe and Massachusetts was deduced and illustrated by tables. The savings banks were called upon to keep special books for the information of the bureau, and 115 out of 169 complied. Considerable matter of minor importance was secured by visits of agents, and a few extracts from foreign documents were made for purposes of illustration or comparison.

The report for 1875 was mainly the result of personal investigation by the agents of the bureau. They visited the half-time schools, and reported their condition and prospects. Certain branches of employment were personally inquired into, and their special effects upon female health demonstrated. Immediately after the disaster at Granite Mills, an agent of the bureau visited Fall River, and elicited important facts from nineteen individuals and families. From the sworn returns obtained in the year previous, tables were prepared showing the means of egress, in more than two hundred mills, from upper stories in case of fire or panic. The statements made were lately put on trial in a court of law, and several mill agents and superintendents testified that, as far as their knowledge extended, the descriptions given by the bureau were entirely correct and trustworthy.

The condition of 397 workingmen's families was ascertained by the investigations of agents. The mode of procedure in this work is thus described in the report:—

"The agent, upon arriving in a place selected for investigation, and, knowing its prominent or peculiar industries, visited the mill, workshop, wharf, public works or foundry, as the case might be. Accosting the first workman at hand, a statement of what was desired was made; in case of compliance, a time was fixed, convenient to the workingman, at which to supply the desired figures and information; in case of inability or want of inclination, application was made to one and another of the workmen, and at other establishments, until the desired number was secured. Visits by day were made in order that the locality and the immediate surroundings of the houses could be examined, and visits in the evening were required, for then the workmen could refer to their account-books and bills, and find the items of expenditure of their cost of living. As a matter of fact, our returns would have been materially smaller in number, or wanting in completeness, but for these evening visits made after work was done. The rooms were inspected, and their pleasant or unpleasant features noted. The children were at home, and the physical appearance and dress of the family were observed."

Attempts to secure information concerning co-operation, by circulars, proving, as usual, a comparative failure, the efforts of agents supplemented the work, and secured all available data. The report contained much selected information, obtained by the personal investigations of Hon. Edward Young, Hon. C. C. Andrews, United States minister to Sweden and Norway, and from documents secured by the chief of the bureau while in Europe.

The manner of working, as regards the state census and industrial statistics, will be fully explained in its appropriate section.

The report for 1876 is wholly the result of personal investigation, the blanks used forming part of the census system. They were left with individuals by the enumerators, information given when necessary, and when collected were examined to supply deficiencies and correct errors. The number of available schedules received was 71,339, of which 55,515 were filled by males and 15,824 by females. The information gained is presented with regard to sex, to wage and salary receivers, and by families, cities, towns, counties and important occupations. The points of inquiry were as follows:—

Persons dependent.
Hours employed daily.
Days employed yearly.
Daily wages.
Yearly wages.
Other earnings.
Wife's earnings.
Children's earnings.
Unable to work from sickness.
Persons owning houses.
Mortgages on houses.
Rate of interest on mortgages.
Rents.
Number of rooms hired.
Value of garden crops.
Cost of living.
Volumes in private library (over 100).

This report, being the seventh in the series, will be sent on application, and prepayment of postage, until the number provided for distribution is exhausted. By law of the State, all public documents are furnished free of expense to parties desiring them.

IX.—Distribution of Reports.—Opinions of the Public and the Press.

During the seven years of the bureau's existence, about fifty thousand copies of its reports have been published by order of the legislature. As is usual with public documents, the members of the Senate and House have received liberal quotas for distribution among their constituents; but at least one-half of the number published has been placed at the disposal of the bureau. No rigid rules have been applied in their distribution, but any person desirous of reading a report has been accommodated. The demands have come, of course, primarily, from the citizens of Massachusetts; but persons in every State of the Union, the newspaper press, public and social libraries, other state governments, institutions of learning, and scientific and literary associations have been supplied. The foreign circulation has also been large, and divided among classes similar to those given above.

It would be useless to print a representative home list of a hundred names from the alphabetical records of thousands which are kept by the bureau; but any person desiring to study statistics, or wishing to investigate labor subjects, can obtain great aid from the correspondence-roll of the bureau, which is freely placed at his disposal. In order to accommodate such parties, however, we present below a selected list from our foreign records. It will serve a double purpose, by giving an idea of the circulation of the bureau reports in Europe, and by furnishing the names and addresses of the prominent statisticians of Europe.

DISTRIBUTION OF BUREAU REPORTS IN FOREIGN COUNTRIES.

Edinburgh Workingmen's Club, Robt. McLaren, Secretary, Scotland.

Joseph White, Southgate Mills, Bradford, Eng.

Friedrich Krupp, Essen, Prussia.

Alexander Redgrave, Factory Inspector's Office, London, Eng.

Robert Baker, Factory Inspector's Office, London, Eng.

Samuel Stepney, Factory Inspector's Office, London, Eng.

Freiburg University, Baden.

Foreign Office, Imperial Government, Vienna, Austria.

Geo. Potter, London, Publisher of "The Bee-Hive."

Alsager Hay Hill, London, Publisher of "Labour News."

"Co-operative News," Manchester, Eng.

A. J. Mundella, M. P., Elvaston Sq., London, Eng.

Geo. B. Emerson, London (care Baring Bros.).

R. Applegarth, London, Eng.

Wm. Allan, London, Eng.

John Kane, Darlington, Eng.

A. A. Self, London, Eng.

W. H. Blatchley, London, Eng.

T. Dunning, London, Eng.

C. Bradlaugh, London, Eng.

Prof. Beesley, London, Eng., London University.

Sir Chas. Dilke, House of Commons, London.

J. Geo. Eccarius, London, Eng.

Thomas Hughes, London, Eng.

Geo. J. Holyoake, London, Eng.

John Leigh, Manchester, Eng.

Institute Technology, Manchester, Eng.

Miss Emily Faithfull, London, Eng., Victoria Press.

Geo. Howell, London, Eng.

Felix Heikel, Helsingfors, Finland.
Paul Liptay, Hungary.
London Statistical Society, London, Eng.
Hon. Geo. P. Marsh, Rome, Italy.
General Registry Office, London, Eng.
Dr. William Farr, British Museum, London, Eng.
Frederick Purdy, Poor Law Commission, London, Eng.
Henry Longley, Local Gov't Board, London, Eng.
G. W. Hastings, Social Science Association, London, Eng.
William Tallock, Howard Prison Association, London, Eng.
F. Cowell Stepney, London, Eng.
J. R. Whitehead, M. P., Leeds, Eng.
Mr. Foster, M. P., Leeds, Eng.
Edwin Hill, London, Eng.
M. D. Hill, Court of Bankruptcy, Bristol, Eng.
University Library, Cambridge, Eng.
"Westminster Review," London, Eng.
Mrs. Charlotte A. Joy, Isle of Wight, Eng.
Sir James Cox, Board of Lunacy, Edinburgh.
Registrar-General, Edinburgh.
"Edinburgh Review," Edinburgh.
Glasgow College, Glasgow.
Inspectors of Lunatic Asylums, Dublin.
Poor Law Commissioners, Dublin.
Registrar-General, Dublin.
Chief Secretary of Government, South Adelaide, Australia.
Dr. F. Norton Manning, Sydney, New South Wales.
Minister of Justice, Paris.
M. le Garde des Sceaux, Paris.
M. Bonneville de Marsagny, Paris.
M. Galzard, Statistical Society, Paris.
M. A. Legoyt, Gen. Statistical Bureau, Paris.
M. Roux, Statistical Society, Marseilles.
Dr. B. A. Morel, Rouen.
Government of Holland, The Hague. By U. S. Minister.
Dr. Von Baumhauer, Statistical Bureau, The Hague.
Government of Belgium, Brussels. By U. S. Minister.
Emile de Laveleye, Liege, Belgium.
Prof. Le Roy, Royal University, Liege, Belgium.
M. A. Visschers, Central Statistical Commission, Brussels, Belgium.
M. A. Quetelet, President Central Stat. Com., Brussels, Belgium.
M. Stevens, Inspector Gen. of Prisons, Brussels, Belgium.
Sig. Beltram Scaliar, Inspector Gen. of Prisons, Rome, Italy,
Sig. Dr. Maestri, Royal Bureau of Statistics, Rome, Italy.

Dr. G. Neumann, Berlin, Prussia.
Dr. Ernst Engel, Bureau of Statistics, Berlin, Pru
Dr. F. Von Holtzendorf, Prison Commission, Berli
Dr. Hach, Lubec.
Dr. Charles Dippe, Mecklenburg-Schwerein.
Dr. C. W. Ascher, Hamburg.
Dr. Von Holtz, Heidelberg, Baden.
Dr. Geo. Varrentrapp, Geographical and Statis. S
fort.
Dr. Von Sewelof, Statistical Bureau, Hanover.
Dr. F. B. Von Hermann, Statistical Bureau, Munic
Dr. Weinlig, Statistical Bureau, Dresden, Saxony.
Prof. Ed. Wappaus, Gottingen University.
Joseph Bernal, Bureau of Statistics, Prague, Bohe
J. Ritter Von Engelhardt, Gov't Stat. Bureau, Vie
Baron de Goering, Vienna, Austria.
National Museum, Pesth, Hungary.
Dr. Goss, Geneva, Switzerland.
Dr. H. C. Lombard, Geneva, Switzerland.
Prof. E. Decor, Neufchâtel, Switzerland.
M. Max Wirth, Central Bureau of Statistics, Berne
Polish Historical Museum. Sent to Le Comte Le
Switzerland.
Francisco G. Martini, Director of Education, Madr
Dr. Fred. Theodore Berg, Central Bureau of Sta
holm, Sweden.
Christiana University, Norway.
M. Pierre Semenou, Director Central Statistical C
Petersburg, Russia.
H. Fawcett, M. P., London, Eng.
Lloyd Jones, London, Eng.
John Stuart Mill, London, Eng.
London Society for Suppression of Mendicity.
John Ruskin, London, Eng.
"London Times."
"London Telegraph."
Gen. Archibald, British Consulate, New York.
Harris Gastrell, British Legation, Washington, D. C
G. A. Schmitt, Austrian Consul, Boston.
M. Marshall, Cambridge, England.

IX.—Opinions of the Public and the

From the wide circle of readers of the reports
of commendation and of criticism have been nu

is beyond the desired compass of this volume to give even brief extracts from the communications received, and a few selections might seem invidious or partial. The manner in which the friends of labor reform, whatever their particular ideas on the subject might be, have rallied to the support of the bureau when its continued existence has been in doubt, shows plainly that the need of the bureau is felt, and a belief in its usefulness is widely extended.

The officers said, in 1873, "We have continued assurances from laboring men, from labor newspapers, from labor organizations, and from leading labor reformers, that they will sustain the bureau in its investigations." We have no doubt that such is the general feeling at the present time.

It must not be supposed that the manufacturers of Massachusetts are leagued in opposition to the bureau and its work. As a general rule, they have given every desired facility to the bureau's agents, and have manifested, in many instances, a deep interest in the bureau's work. Of course, there have been many exceptions found. Many consider the investigations inquisitorial, insulting, etc.; and many, knowing they were violating the law, have shown great opposition to the proximity of its officers.

The statisticians of the country have complimented the bureau's work, and, in many cases, offered valuable suggestions, which have been followed.

The newspapers have shown a general desire to lay abstracts of the reports before their readers, and many have devoted editorial space to the serious consideration of facts presented. Considering the impersonality of newspaper articles, we shall venture to give a few extracts from editorial remarks.

The second report of the bureau is thus referred to by "The Nation," of New York, dated June 1, 1871:—

"THE LABOR QUESTION IN MASSACHUSETTS.

"It is difficult to exaggerate the value of such labor as is so intelligently performed by the Massachusetts Bureau of Statistics of Labor, whose second annual report has been recently presented to the legislature of that State.

"The report itself is a model for clearness, system and practical arrangement, and especially for a thorough recognition of the nature of the facts required by a body of legislators, though it is much to

be feared that they will be the last to be benefited thereby. It does not need a very close scrutiny to recognize that General Oliver, the chief of the bureau, is in warm sympathy with the workmen, and, from conviction, inclined to their views. But, after a careful study of the volume, we acquit the authors of every suspicion of partiality in what was, after all, the main work, the collection of the facts themselves; and these are of the utmost importance.

"That the reading of such reports as General Oliver's will convince many persons of the gravity of the evil, and reconcile them to the freest and most exhaustive discussion of the remedies, is the chief, as it will be the most immediate, result of the establishment of the bureau itself.

"It is unfortunately true, that the prejudice against anything savoring of so-called labor reform, for the moment, almost bars its intelligent discussion, and it is to be regretted that the extreme bulk of this volume will prevent many from examining it, who might otherwise contribute to make its contents known. But the mere existence of a permanent bureau, authorized to take testimony on the subject, and capable of exercising that authority with fairness and intelligence, is a long step towards a correct understanding of this great problem."

The "Springfield Republican," April 26, 1872, contains the following concerning—

"The Labor Bureau's Report.

"Each successive year increases, perhaps we may say, doubles, the value of the annual reports sent out from the Massachusetts Bureau of Labor Statistics. General Oliver, the chief, and Mr. McNeill, the deputy of the bureau, who unite in writing the reports, come every year somewhat nearer to comprehensive acquaintance with the myriad facts that make up the industrial problem of Massachusetts; moreover, they acquire a better method of setting them forth.

"But it will still be some years before the statistics thus presented will have the weight that belongs to carefully collected and accurately analyzed results; for it is not yet possible, in any branch of the inquiry, to allow for all the facts that ought to be known and considered."

The "American Artisan," of May 29, 1872, says:—

"The institution and maintenance by the State of such a bureau, cannot be too highly commended, and the gentlemen whose inde-

fatigable and judicious labors have produced the work before us, are entitled, not only to the thanks of the Commonwealth of Massachusetts, but of the country at large."

The Boston "Commonwealth" spoke thus strongly of attempts to abolish the bureau in 1872:—

"So the effort now is to abolish the Bureau of Labor. The struggle between capital and labor is growing bitter,—bitter, now, even on the side of capital. It objects to investigation of its methods.

"Let us find, rather, the true 'state pride,' that shall dare seek out its own evils for correction. There is no shame in any quotation of our difficulties made from *our own* investigation and confession in reports.

"Abolish the bureau in a scare, lest we find something wrong, and in time somebody else will be trumpeting our difficulties and also our degradation. Then, indeed, may we blush and dread exposure. Only in the continuance of the Labor Bureau is there honor and integrity. Its abolition would be simply cowardice."

An issue of the New York "Weekly Tribune" (March 11, 1874) thus examines into—

"THE FACTS ABOUT THE WORKING CLASSES.

"A knowledge of the elements of the labor problem is essential to all progress in dealing with it. The proverb, that one-half the world does not know how the other half lives, is nowhere so true as in respect to those who do and those who do not earn their living by manual toil. More light is thrown upon this subject by the facts gathered in such reports as that of the Massachusetts Labor Bureau, which we present elsewhere, than all the fine-spun theories of doctrinaires or the rant of labor demagogues would furnish in a century.

"Previous to the organization of that bureau, it was generally believed that Massachusetts was a model Commonwealth, far superior to the rest of the world in respect to the education of her masses. The training of her common schools was her glory and her pride; and however necessary compulsory education might be under effete governments, here, at least, was a State where the children of the poorest citizen were proficient in the three r's. Unhappily, the statistics of the Labor Bureau tell a very different tale. The children of working people in Massachusetts are, in great part, as sadly neglected in respect to education, as if they were born in the middle of Africa. There are 25,000 of them, between the ages

of 5 and 15, thrust into the workshop instead of the school-room. The report says that they do not receive the slightest education, either in public or in private schools. What sort of citizens will they make, when, under our equal laws, the ballot is placed in their hands? Of what avail will books or newspapers, or any other means of enlightenment, be to this army of heathens who cannot read?

"How do they live, these working people,—these people whom we only hear of when they rise in a strike; or begging for work, come to the soup-kitchens? The report photographs their life with painful fidelity. While they have work, their hours are long,—especially those of women and young girls. They occupy vile tenements as homes, where they are packed closely, without regard to decency or health; where sight and smell are offended at every step, and vice and drunkenness offer the only variety of their monotonous lives. Doubtless, this is not true of all; but of how terribly large a proportion it is true we are told in the report. They save something against a rainy day? Yes, more than was at one time supposed; and of the depositors dependent upon day wages, the savings banks hold an average to each name of $121. But a large proportion save nothing; and there is a strange feature in this matter of saving—those save most who earn least; the workmen who can earn large wages are very rarely frugal.

"There are excellent recommendations at the close of the report, to which the only objection is, that they are too general in their character. The best of laws, the wisest management on the part of the State, cannot wholly meet the exigency. Philanthropy and capital must go hand in hand, and, having sought out these evils and ascertained their origin, must find the true solution of the labor problem in the elevation of the workingman."

The New York "Graphic," in a series of four articles, considered the bureau report for 1874. The issue for March 13, 1874, contained the following editorial upon the—

"Homes of the Poor.

"Some of the facts brought to light by visitors among our poor people are heart-harrowing enough. A large number of young women, moved by a spirit of commendable charity, have gone among the homes of the poor of the city this winter, to carry relief and comfort to their wretched inmates. The pictures of destitution, squalor, and nauseating filthiness they paint, are enough to make the strongest soul sick. In some instances the visitors have

been so affected by the odors and infections of the stived tenements, where scores of human beings are huddled together, as to be incapacitated for further work. It is doubtless true, that one-half of the world does not know how the other half lives. But after listening to and reading some of the accounts of these voluntary visitors among the poor, it is a wonder that a large class of our fellow-beings live at all.

"The same state of things is exhibited, in an equally striking way, by the report of the Massachusetts Bureau of Statistics of Labor. The commissioners devote special attention to the dwellings of the poor in that State. They found a large proportion of them dingy, unventilated, unwholesome, and thoroughly demoralizing in every respect. We give some of the facts in another column. They tell their own story. And here is one of their instances: 'In a single building, in the town of W., thirty-two feet long, twenty feet wide, three stories high, with attics, there habitually *exist* thirty-nine people of all ages. For their use there is one pump and one privy, within twenty feet of each other, with the several sink-spouts discharging upon the ground near by. The windows are without weights, and the upper sashes are immovable. No other provision is made for fresh air. Scores of similar overcrowded and uncleanly tenements exist and could be cited.'

"The effect of such habitations on health and morals must be incalculably bad. It is not surprising that people who are compelled to live in tenements unfit for horses, or even swine, resort to the dramshop when the work of the day is over, and try to hide their wretchedness from themselves in the convivialities of a well-lighted saloon and the delirium of intoxication. Nor is it surprising that the inmates and progeny of such homes are sickly, thriftless, ignorant, often vile, and sometimes violent. These miserable rookeries, rented at extortionate rates by rich capitalists, are the prolific nests of crime. If anything is to be done to save society from the depredations of criminals, to check pauperism, intemperance and vice, the work must begin at the beginning. It is the springs that make the river. Edward Everett remarked that many of the children in a dark and filthy court at the North End of Boston were blind from their birth. Soup-kitchens and labor demonstrations may be well in their way; but before any permanent amelioration of the condition of the poorer classes can take place, they must be better housed and conditioned. Health and morals require something more than soup and sentiment. Relief must give way to a reform that goes back to the sources of the difficulty. Dr. Holmes has said, 'There are people who think that everything may be done, if the doer, be he educator or physician, be only called "in

season." No doubt; but *in season* would often be a hundred or two years before the child was born, and people never send so early as that.' We must prepare for a better state of things in the next generation, by laying the foundations in this. A true civilization thinks more of characters than commodities, and will not consent to use up human beings for the sake of cheapening cloth a cent in the yard. The test of a civilization is the estimate in which it holds human beings. It is not how the rich ride, nor what they wear, but how the people live and what sort of houses they live in, that determine the character of a commonwealth."

The Brooklyn "Daily Argus," of March 17, 1875, devotes much space to the consideration of the bureau's work. It says:—

"Intelligence and system characterize many features of Massachusetts legislation, especially those that relate to labor and education. Our own Empire State ought to do for its imperial population what Massachusetts does for her children. Call it 'Yankee inquisitiveness,' or what you will, the old Bay State *does* inquire and investigate and reform. Her officials penetrate below the surface of life, and question all the needs of her people. No State in the Union has more complete returns to illustrate the sociology of its population, to ameliorate their condition, and to protect interests—sanitary, educational and moral—which go to frame the organization of a well-ordered commonwealth.

"Brooklyn is so largely made up of that New England element, which has the Massachusetts character for its dominant type, that her social condition is reflected in that of the ancient Puritan Commonwealth. The latest report of the Massachusetts 'Bureau of Statistics of Labor,' which has been made with most painstaking care, furnishes a multitude of facts and suggestions which are of application here, and which will interest a Brooklyn audience.

"The most interesting and practical part of the report is that which relates to the condition of the families of workingmen, such as day laborers, tradesmen and others who are obliged to depend for support on the work of their hands.

"One general fact appears,—that, while the wage system enables a minority of the workingmen to maintain themselves and families comfortably by their individual exertions, in a majority of cases they must have aid from wife or children to accomplish this result. The result shows that co-operation in the purchase of supplies is an economy of earnings, and that such a system is of great value to the laborer and the artisan.

"It would be interesting to have returns like these in Brooklyn; but the Massachusetts statistics are of universal application, and may be applied, with only slight variance, to the condition of affairs here.

"The general conclusions of the report come home to every laborer and artisan wherever he may live. They impress the necessity of steady employment, of economy, and of co-operation.

"They furnish little justification for 'strikes.' We commend them to all who are dependent upon manual labor or small salaries."

The "Chicago Tribune," of March 19, 1875, says, editorially:—

"The Massachusetts Bureau of Labor Statistics has issued its sixth annual report. We regret to learn, from the abstract that has reached us, that there is danger of the abolition of the bureau. Its reports have been of the greatest value to the student of social science. They are quoted from Maine to Oregon, and are in demand throughout Europe. There is no other organization in the country which does a like work, for the Pennsylvania Bureau of Labor has as yet shown no reason for its existence. The six Massachusetts reports contain a mass of information which is obtainable nowhere else, and the subject is far from being exhausted. It is to be hoped that the good work may go on. These statistics show a better state of things, on the whole, than was expected. The decrease in wages, due to the panic, has deprived the Massachusetts workingman of his luxuries. Otherwise, he seems to be getting along well enough, so far as the present is concerned. He has slight chances for the future, however. 'In only a few cases,' says the report, 'is there evidence of the possibility of acquiring a competence.' As long as this is true, so long is labor wronged,—but it is usually wronged by itself. The husband and father 'has given hostages to fortune.' Where labor is too plenty, labor is too cheap, and a life of toil often ends in a pauper's grave. The bureau hopes great things from co-operation in the way of bettering the condition of the working classes, and in this it is right. In England and Germany, there are millions of workingmen living in comfort who, without co-operation, would be in squalid misery."

X.—Results of Seven Years' Investigations.

It would be impossible to consolidate in a few pages the arguments, testimony, narrative, statistical tables, conclusions and recommendations contained in the *four thousand* pages of

the seven reports already issued. With the design of giving, as far as possible, the results of the seven years' investigations, we first present a complete digest of the work of the bureau, arranged by important subjects, and having the report, volume and page given, in order to aid those desirous of reading up on any particular point, or in finding the details of each subject considered.

DIGEST OF THE BUREAU'S WORK.

[The Roman numerals indicate the volume of the Report. Vol. I. was issued in 1870; vol. VII. in 1876.]

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From the testimony, narrative, statistics and arguments comprehended by the preceding digest, the officers of the bureau felt warranted in drawing certain conclusions, and thereupon making various recommendations to the legislature of Massachusetts. These conclusions and recommendations embody the *practical results* of the seven years' investigations. The most important of these conclusions we give hereinafter, accompanied, in some cases, by a statement showing the weight of proof sustaining them, and secured legislation relating thereto. The arrangement of subjects adopted in the digest is retained, as far as practicable, in the following presentation. It should be borne in mind, that the officers in 1870, 1871, 1872 and 1873 were Messrs. Oliver and McNeill; in 1874, 1875 and 1876, Messrs. Wright and Long.

Hours of Labor.

The report for 1870 contained the following conclusion and recommendation:—

"That the hours of labor are too long, and that the preliminary step to remedy the evil, is the enactment of a law restricting labor

in all manufacturing and mechanical establishme
ten hours per day, or to sixty hours per week."

The report of 1871 again recommended—

"The establishment of ten hours as the limit
all manufacturing and mechanical or other esta
State wherein men or women, or both, are employ

The report for 1872 more specifically rep
mendations of the two preceding years:—

"We therefore recommend that the Common
ploying capacity, adopt the example set by the
by some of the individual States, of abridging th
manual laborers in her employ, either by contrac
that the experiment may be tried, at public e
reduction of hours is, or is not, an increase of w
recommend that a law be enacted, similar to th
Great Britain, limiting the hours of labor in
mechanical or other establishments in the State, to
any one day, or sixty hours in any week; and th
thirteen years of age, shall be employed in any su
nor at any age, unless such child has received the e
mon school education, and shall be physically quali
—age, education and physical condition to be ma
cate provided for by law; and further, that all chil
teen and fifteen years of age, so employed, shall
more than five hours in any one day,—said hours
o'clock in the forenoon and six o'clock in the aft
they shall attend school, vacations excepted, three
every day; the same law to compel protection ag
unguarded belting, machinery, elevators or hoist-
be enforced by specially appointed inspectors, who
to enter the premises of any establishment whe
make research and to enforce the law."

The report for 1873 repeated the above r
That for 1874 contained much statistical info
upon the matter, which will be referred
report for 1875 says upon the subject:—

"The legislature, by Act of 1874, has virtuall
day's work at ten hours, and a further reducti
attempted till other matters have been dealt with

believe, that, when the other matters have received the attention they deserve, the hours of labor will take care of themselves.

"The law of last year was passed under similar circumstances which attended and followed the passage of the English ten-hour law. The latter went into effect almost immediately, not so much from the desire of manufacturers, as from the effect of the financial crisis which existed.

"Working-time was reduced on account of the times, by and for the manufacturers themselves, and when the crisis had passed, it was not found easy to return to the old hours, and so the ten-hour law came into operation with facility. And it is or will be the same in this State; and although a few mills have sought to evade its provisions, we anticipate a general and easy acquiescence in its provisions, and as time advances, the wisdom, or the want of wisdom, of the legislature will be proven. At present, the only serious wrong which exists, so far as working-time is concerned, affects married women and young children."

The text of the ten-hour law referred to above will be found on page 37. The arguments used against its adoption were the same as those relied upon in England, when the passage of a similar law was under consideration.

The discussion of the hours of labor question brought out many points of interest and value. The fact that going and coming from work forms a material addition to the labor day was demonstrated,—low wages compelling a workman to seek cheap tenements far from the centres of industry and population. The Fall River mills began running, voluntarily, January 1, 1869, on the ten-hour plan, and continued for *twenty-one months*, when they were obliged, by competition and other causes, to return to eleven hours. The statistics given in the report for 1874 bore directly upon the subject. In twenty-seven leading occupations compared with England, three required fewer hours in Massachusetts than in England; eight required the same hours in both countries; sixteen industries (including boots and shoes, cotton and woollen goods) required more hours in this State than in England. The following table, showing the time run by Massachusetts mills prior to the passage of the ten-hour law, is from the report for 1874:—

"In 283 textile manufactories in the State of Massachusetts, the hours of labor per week are as follows:—

19 mills run	60	hours per week.	
48 "	$62\frac{1}{2}$	"	"
5 "	$63\frac{3}{4}$	"	"
86 "	$64\frac{1}{2}$	"	"
111 "	66	"	"
14 "	66 to 70	"	"

"Estimating the average of the 14 last named as 68 hours, the average of the 283 mills is very nearly $64\frac{3}{4}$ hours per week."

The figures gained by the State census of 1875, and used in the preparation of the report for 1876, are well-nigh incontrovertible. Counting in all kinds of labor, 53,304 males reported the time employed daily as $10\frac{21}{100}$ hours, and 13,507 females, $10\frac{49}{100}$ hours. The males worked $241\frac{85}{100}$ days in the year, and the females, $258\frac{96}{100}$. If they could have been employed *regularly* on the 308 working days of the year, they could have obtained their yearly earnings by an average day's labor of *eight hours* for males and *eight hours fifty minutes* for females.

We have said the above figures are well-nigh incontrovertible. The industrial statistics for 1875 obtained the hours employed daily, the daily wage, and the days employed yearly for 300,000 workingmen and women in this State; when the final figures are arrived at, as far as statistics are concerned, the questions of hours of labor and earnings will be settled, for a decade at least. The industrial statistics of Massachusetts, soon to be published, will contain the results referred to, with special reference to sex, particular occupation, piece or day work and age.

Kind of Labor.

The United States census of 1870 has supplied the only reliable information that the bureau has had as to the number of persons engaged in the various industries of the State, but the classification was not sufficiently minute to be of great value. The State census for 1875, when published, will give the occupation of every person in the State *by its exact name*, and with a classification as to age. As a basis for correct thought and proper legislation, the resulting

figures will be invaluable. The ratio of the producing and non-producing classes will then be definitely established.

Condition of Working People in their Homes and Employments.

The report of 1870 recommended,—

"That the whole subject of tenement-houses, their evils, and the remedies therefor, and the enforcement of all laws relating thereto, be committed to the State Board of Health."

It also declared the belief of the officers,—

"That there is peril to life and limb from unguarded machinery, and peril to health from lack of ventilation, and insufficiency of means of escape in case of fire, in many establishments, and that these evils can only be prevented by detailed enactments.

"That there will be great difficulty in carrying any remedies into effective force, excepting by establishment under law of a system of inspection, as in England."

The report for 1871 took the same ground as that of 1870, in relation to tenement-houses and a system of factory inspection.

The report for 1872, thus refers to tenement-houses :—

"Our exposure of tenement-houses has excited a deep and effective interest in the real condition of the homes of low-paid laborers, and led the way to means of relief, and, perhaps, of remedy."

The report for 1874 considers that—

"To produce the better *status* of the working classes there should be,—

"1. An effort in his own behalf on the part of the workingman to remove from himself the evil influences, physical and moral, that too greatly surround his home.

"2. An organized effort on the part of philanthropy and capital conjoined, to aid him in this work, by the creation of cheap, healthful and comfortable homes.

"3. A co-operative effort on the part of employer and employed to secure for the benefit of both the most favorable hygienic conditions of employ.

"4. A care that certain requirements of existing law, statute and physical, should receive full recognition in the employment of labor as affecting females in particular.

"5. A union of capital and labor to forward the vital int both, in home and factory, in the securing of the supplie the care of the sick, and their kindred interests. 'Not fea we do too much, but lest we do not enough.'"

The same volume says, concerning the homes of w men:—

"The great want of Fall River is better homes for the op There are hundreds of tenements that are really unfit to entirely without the comforts, and with very few of the necessary conveniences of a home. But a change is taking and great credit is due the following corporations for thei prise in building tenements for the use of their operatives: ics, Davol, Sagamore, Weetamoe, Flint, Wampanoag, King Border City, Chace and Slade. The tenements are comn comfortable, well arranged, in healthy locations, and very advance of anything of the kind in Fall River."

The report for 1875 arrives at the following conclusi relation to the employment of women:—

"We believe: That the employment at labor of any gi fifteen years of age should not be allowed.

"That the employment of girls of other ages—and women ally—at employments unsuited to their sex, should not be (such employments being determined by a council of salub France, composed of those most eminently fit for their hi mission).

"That in such employments as women should be admi they should be permitted a 'periodical absence,' without pe loss for such time, as might be just and necessary.

"That in employments where women should be admitt which require high degrees of mental concentration, with p energy, additional vacations of sufficient extent should be th of the employé.

"That in all employments it should be obligatory up employer to conduct the processes of the occupation under th advantageous conditions to health, and to secure all improv in this regard that may become approved.

"That in all larger manufactories (of over certain num employés) there should be special sanitary supervision, expense of the proprietors.

"That there should be a well-established examination and

cation of all employés, male and female, proposing to engage in any deleterious or burdensome employ,—only those being certified who are found in the possession of health not to be unduly impaired thereby, and only such to be employed as are certified."

The same report says, in relation to the Granite Mills disaster at Fall River:—

"A repetition of this disaster should be made practically impossible. No love of gain should be allowed to put human life at risk. The number of manufacturers who *knowingly* endanger the lives of their operatives is probably very small in this State; but there are undoubtedly some, and these should be restrained by law. There are many more who take every means that they consider necessary to insure the safety of their operatives. These need law for enlightenment. Here and there can be found manufacturers who foresee and provide against every conceivable accident; but these men are exceptional, and always will be. Other men, whose love of gain may be no stronger, and whose hearts may be as tender, continue to endanger the health and lives of their employés through sheer ignorance or thoughtlessness."

In a general consideration of the subject of the condition of working people in their employments, the report for 1875 says:—

"To remedy what we have referred to, requires, it seems to us, a simple, comprehensive factory Act, which shall clearly define the duties of mill-owners, as to the protection of machinery, ventilation, etc., of rooms, fire-escapes and the employment of children, and, if possible, of married women, and the regulation of their hours of labor; and which should also clearly define the duties of parents; the law should provide fines for both owners and parents for violation of its provisions; a suitable number of inspectors should be provided, to see that all the provisions of the law are fully carried out, and also to see that the laws relating to the education of children of operatives are enforced."

A factory Act, of which an outline is given on page 300, was suggested as a means of carrying out the above provisions.

As the results of an investigation into the manner of living of about four hundred families of workingmen, the following conclusions were arrived at:—

greatest number of child workers occupy the most crowded rooms and the inferior class of tenements.

"*Second.* That about three-quarters of the workingmen's homes which we visited are in good condition as regards locality and needful sanitary provisions; but,—

"*Third.* That nearly one-half of the unskilled laborers live in the inferior tenements.

"*Fourth.* That the working classes of Massachusetts, judging from our investigations, are well fed.

"*Fifth.* That their food, in variety and quality, is above the average of that consumed in foreign countries, and that, as regards quantity of animal food used, their 'higher level' is unquestionable.

"*Sixth.* That, as far as our investigations extended, our workingmen are, on the average, well and comfortably clothed.

"*Seventh.* That their manner of dress is, at leas capable of most favorable comparison with that in foreign countries.

"*Eighth.* That a large proportion of the skilled workingmen visited have sewing and other labor-saving machines in use in their families.

"*Ninth.* That, as evidences of material prosperity to a certain extent, significant numbers of the families (the aid of child labor being fully allowed) own pianos or cabinet-organs, have carpeted rooms, and maintain pews in church."

WAGES, EARNINGS, COST OF LIVING, SAVINGS.

Previous to 1875 many investigations had been made by th bureau into the wages, earnings, cost of living and savin of workingmen, but the small number of cases examined ir invalidated, to a certain extent, the conclusions derived th from. In 1875 the investigations covered about four hun families, and each family made *complete returns on all p* considered. The conclusions arrived at were, as re *earnings,*—

"*First.* That, in the majority of cases, workingmen in t monwealth do not support their families by their individual alone.

"*Second.* That the amount of earnings contributed generally speaking, is so small, that they would save m ing at home than they gain by outside labor.

"*Third.* That fathers rely, or are forced to depen

children for from *one-quarter* to *one-third* of the entire family earnings.

"*Fourth.* That children under fifteen years of age supply, by their labor, from *one-eighth* to *one-sixth* of the total family earnings."

As regards expenses,—

"*First.* That, judging from the proportionate outlay for dress, as regards entire expenses, there is no evidence that the workingmen we visited, in obedience to fashion, indulged in an excessive or disproportionate expenditure.

"*Second.* That, from our investigations, we find no evidence, or indication, that workingmen spend large sums of money extravagantly or for bad habits.

"*Third.* That, as regards subsistence, rents and fuel, the workingmen's families which we visited paid therefor larger percentages of their income than do workingmen's families, with like incomes, in Prussia and other European countries.

"*Fourth.* That, as regards clothing and sundry expenses, our workingmen's families paid therefor smaller percentages of their income than do workingmen's families, with like incomes, in the countries mentioned above."

And, finally, as regards *savings*,—

"*First.* That more than *one-half* of the *families* visited save money; less than one-tenth are in debt, and the remainder make both ends meet.

"*Second.* That, without children's assistance, other things remaining equal, the majority of these families would be in poverty or debt.

"*Third.* That savings, by families and fathers alone, are made in every branch of occupation investigated; but that in only a few cases is there evidence of the possibility of acquiring a competence, and, in those cases, it would be the result of assisted or family labor.

"*Fourth.* That the higher the income, generally speaking, the greater the saving, actually and proportionately.

"*Fifth.* That the average saving is about *three per cent* of the earnings.

"*Sixth.* That while the houses of the workingmen visited compare most favorably with those in foreign countries and other States in the Union, yet, in certain of the United States, workingmen have better opportunities for acquiring homes of their own."

savings banks,—

"That the increase of the deposits in savings banks is not an evidence of the increased means of the working classes, but that, on the contrary, the instances into which we have been able to examine, prove that the greatest *amount* of deposits is not the deposits of wage laborers."

From returns three times as numerous as those obtained the year previous, the report for 1873 draws these conclusions:—

"*First.* That notwithstanding the commonly received opinion, the fact is that all the money on deposit in our savings banks is *not* the savings of wage labor, distinctively so called.

"*Second.* That from what is known to be the average annual earnings of wage laborers, and the average annual cost of supporting the average sized family of such laborers, a wage laborer cannot in any one single year, as a rule, save out of his earnings a sum of money equal to the average deposit of $573.33, that being the average for the year 1870, of parties depositing in sums of and over $300 at one time.

"*Third.* That beyond question, the depositors in our savings banks are, *in large excess*, as we have said, members of the wage earning class; the deposits under $300, for the year 1870, being c the average $55.20 at one time.

"*Fourth.* That equally true it is that the safety, regularity good management, financially, of these banks have allured dep from the great middling class of the community, and that this of depositors is increasing, although the theory of savings declares that they were intended for the poorer classes, they believed to be less able to manage money affairs than the mi trading class, or than professional persons."

The report for 1874, with returns from 115 bank 169, showed the following results: Average deposi wage laborers, $121.72; the average for all depo $152.91. The day-wage class deposited 44.8 per whole amount placed in the savings banks; it 57.7 per cent of the whole number of deposit deposits under $300 at one time, the wage labor 58 per cent of the amount; of those above $30

36.4 per cent of the amount. The salaried, professional and so-called capitalist classes made up the remaining percentages. It will be seen that the conclusions of the bureau officers in 1872 and 1873 were substantially corroborated by the returns of 1874.

The introduction of the bill in 1876, relating to deposits and rate of interest in savings banks, was, undoubtedly, owing, in some extent, to the facts obtained by the bureau.

The report for 1876 contains returns from more than 70,000 workingmen and women, relating to wages, earnings, cost of living, and savings.

About fifty thousand workingmen reported an average annual income derived from usual daily wages, other earnings, earnings of wife and children and garden crops, of $534.99. The average annual cost of living was $488.96. This leaves a possible saving of $46.03 yearly, or 8+ per cent. The returns for 1875 were entirely from married men having families dependent upon them, while the returns of 1876 are, in a great many instances, from single men. This fact may account, in part, for the increase in *percentage* of possible surplus or saving.

About fifteen thousand working women reported an average annual income, derived from the sources above-named, excepting, of course, wife's earnings, of $203.59. The average annual cost of living was $182.86. This indicates a possible saving of $20.73 yearly, or 10+ per cent. The averages for *both* workingmen and women combined, from all the sources given above, were,—earnings, $459.93 ; cost of living, $439.09 ; possible saving, $20.82. The possible average saving, in 1875, was nearly the same, being $24.72.

Results of the Wage System

The report for 1870 expressed the opinion,—

> "That the wage system (though better than the villenage which it succeeded), which has been to the present day the accepted method of distribution of the proceeds of labor, has proved to be adverse in its influence to the general good, and that it should yield to the system of co-operation,—the vital question being, how to educate the people up to the adoption thereof."

The report for 1872 g
clusions:—

"We think that the h
which we have presented,
people,—from the date c
only kept along on a gener
ever, barely paying their w
debt;

"That those who perfor
est number of hours, are t
under existing systems, m
that class which, from the
mence labor at so early a
degree of education, and
ignorant class, from which
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"That poverty—by wh
considerable period of time
of regular wage labor—al
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wage labor, or that syste
most work has been obtai
neous, and should be chan
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"That a reduction of w
but, on the contrary, wage
has a proportionate redu
time."

The report for 1875 i

"It seems natural and
and that his wages should
dence, will comfortably m
educate his children, and
port when his laboring po

The report continues :

"This is what the wage
seems 'natural and just
does it do that is weak an

"*1st. What does it do?* It enables the workingman, in a minority of cases, to comfortably maintain himself and family by his individual earnings; again, it enables the workingman, in the majority of cases, by the aid of the labor of his wife and children, to do the same. In both instances given above, it enables the father or family to keep some of the children at school.

"*2d. What does it fail to do?* It fails to pay the father so much for his labor that he can in all cases support his family on his own earnings, educate all his children up to a proper age, buy a suitable home from his savings, or lay by enough for his decent support when his laboring powers have failed.

"*3d. What does it do that is weak and criminal?* It uses men and women when they are strong, and leaves them to shift for themselves when they are sick, infirm or without employment. This it does by paying no more for labor than the bare cost of existence of the body. It usurps to its benefit the future productive power of the state, by employing children who should be in school or at play, setting at defiance the organic law of production by paying to 44 per cent of the individuals but 24 per cent in wage. It pays to 10 per cent of the workers such small wages that they are in debt and poverty, and it holds out to such unfortunates no promise or prospect of a bettering of condition, but allows them to become objects of commiseration, and to attribute their sufferings to the prevailing system of labor."

After considering the provisions of the National Bankrupt Law and its workings, the report inquires:—

"Why, in justice, should the broken merchant receive the benefit of the bankrupt law, when unable from loss or poor management to pay his bills, and the broken laborer, no more criminal or lacking in good intentions than the merchant, have only the poor debtor's oath to relieve him (and then only from arrest, the debt remaining), with its attendant stultification of his feelings of manhood?

"Why should not the insolvent laborer be discharged from all debts, under the provisions of a general insolvent law (in which the legal fees established should not be so large as to be prohibitory in his case), by the payment of fifty per cent, as well as the bankrupt merchant?

"Firms and corporations, when threatened with loss, reduce expenses, stop manufacturing, and, if necessary, pay half the amount of their bills and begin afresh. The workingman suffers by the suspension of work, cannot reduce his expenses materially, gets in debt,

of debt still hanging to him. Either one thing or the other, it is plain, should be done. Either every competent adult laborer should receive enough as wages (the minimum sum, and as much more as he can command) to enable him to get along without debt, or he should have the same recourse to a relieving law that merchants, corporations or other employers possess."

The consideration of the subject is thus concluded:—

"Much can be rightfully and truly said, as we have shown, against the prevailing wage system, but the iconoclasm that strives to break it down, unless at the same time it shows the superstructure of a more equitable and easily managed one, will be devoid of fruitful results or permanent benefit."

Education and Kindred Topics.

No subject has received more attention from the bureau officers than that of education—with particular reference to working children. Their cause was warmly espoused at the outset, and each year has brought facts, figures and earnest argument bearing upon the question of the schooling of such children. Messrs. Oliver and McNeill have each held the position of special constable for the execution of the school laws, and have done everything possible, by word and act, under existing laws, to secure the right of education to the child-workers of the Commonwealth.

The report for 1870 declared,—

"That the present law in relation to the employment of chil in manufacturing and mechanical establishments in the State dead-letter, and that to remedy this evil an enactment shoul hibit the employment of any child under thirteen years of a at that age, unless such child has received the elements of a school education,—age and education to be matters of due c provided for by law,—and no children under fifteen years ployed in such establishments more than eight hours those to be between seven o'clock in the forenoon and in the afternoon, or within a period of five hours before hours after mid-day."

The provisions recommended in the report of 1871 were still more stringent, requiring—

"The prohibition by law, with appropriate means of enforcement, that no child under thirteen years of age shall be employed in any such establishment, nor at that age, unless such child has received the elements of a common school education,—age and education to be matters of due certificate provided for by law; and, further, that all children between thirteen and fifteen years of age, so employed, shall not be employed more than six hours any one day, said hours to be between six o'clock in the forenoon and six o'clock in the afternoon, and shall attend school, vacations excepted, three hours on each and every day."

To secure the carrying out of the above recommendations, the same report advocated,—

"The establishment of a system of half-time schools for children between thirteen and fifteen years of age, employed in such establishments, and for other children whose avocations deprive them of the benefits of the ordinary full-time schools."

The report for 1872, speaking of the education of working children, says,—

"Attention has been drawn to the fact that large numbers of children in the State are unschooled, and a general demand has arisen for an effective compulsory law and its enforcement. In addition to this, half-time schools are becoming better understood and appreciated."

The same report again advocated the establishment of half-time schools, as did the report issued in 1873. The report for 1874 expresses its convictions as follows:—

"From what we have been able to learn, the law in relation to the employment of children neither is, nor can be, enforced. Should the managers of mills co-operate heartily with the officers of the cities and towns, or of the State, the law could not well be enforced. The testimony of the school boards in some of the manufacturing places is, that often as much difficulty arises from parents as from mill-owners and managers.

"The interest of parent
of the case, compels the f
falsehood, in order to keep
children of tender age, mor
allowed to have a place in
tolerated, and the cheapne
wages of older persons.

"With compulsory educ
come a remedy of this evil,
the operatives; but behind
there should exist that mos
strong, healthy and unmist

"There should be, and
the principle which Massa
education—schooling for a
children are concerned, not
degree, is a dead-letter."

After examining the s
cation, the report contin

"It is safe, therefore,
between the ages of five
education either in our pub
learn, a very large proporti
provisions of the sole facto
was broad enough and prov

The succeeding signs
port:—

"To educate the mill-c
their work, a few cities a
evening schools. Four to
Salem and Springfield,—ha
and cities,—viz., Chelsea,
borough, Medford, Pittsfiel
Ware and Worcester,—hav

"Generally these school
accomplishing a good work

"It is deserving speci
Dedham have a school of
the average attendance i

Hopewell Cotton Mills of Taunton support at their own expense a day school during three months of the year. Also that the Whittenton Mills of Taunton sustain two churches, two Sabbath schools and libraries for the benefit of their operatives. The Pacific Mills at Lawrence have a large library for operatives, the expense of which is sustained partially by the corporation.

"The whole number of towns and cities having evening schools of all kinds is thirty-seven."

The summing up of evidence collected led to the following conclusion and recommendation:—

"Upon this subject of the education of mill-children, there seems to be but one opinion: that the matter is not attended to, either by the state or local authorities; that legislation is desired to compel attendance, to punish illegal employment of children, and to provide proper schools for instruction of operatives, along with work."

The report for 1875, as will be seen by reference to page 297 *et seq.*, took strong ground against the establishment of half-time schools, and as strong ground in favor of compulsory education. The *number* of unschooled children has always been a matter of doubt, despite the returns of the board of education. The census for 1875 will show the number of persons of the school age in the State. The number of children attending school, for at least three months in the year, was also ascertained by an inquiry on the family schedule, and those both at school and at work are specially designated. It is hoped that the results when presented will supply a solution of the question as to the number of uneducated children growing up among us, and indicate where the remedy must be applied. If the law passed in 1876, and given on page 302, is properly enforced, the evils of child labor will be thoroughly known, then mitigated, and finally removed.

Co-operation.

The consideration of the subject of co-operation has not been carried to a great length in the reports. The English successes and failures have been noted and commented on, but the system has failed to take strong root in our laboring

communities, and there has been but little of home pr
to record.

The report for 1870, referring to associations of lab
capital, remarks,—

"That legislation having hitherto favored capital, almost
sively, the remedy for this partiality is the extension of its pro
to labor, so that associations of labor shall be as favorably
nized as associations of capital."

The report of 1873, in its consideration of the progr
labor legislation, says:—

"The time of legislatures, national and state, is occupied
exclusively with the consideration of questions how to incre
facilities by which capital may be accumulated, while ver
time or thought is given to the question how the laborer
lessened work-time and increased means, achieve that ed
which shall elevate him to a truer manhood. With this
leisure, and these increased means, and this better educat
will be able to think out and to work out the methods by
co-operation may safely take the place of wage-labor. For
he looks as the end of the solution of the absorbing quest
issue between capital and labor."

The report for 1874 thus refers to co-operation in th
of Fall River:—

"There is one co-operative store, for the sale of grocerie
visions, meat, and boots and shoes, doing a cash business of $
per year. They have paid to members as profits, during six
$29,760.84. They now own their stores and are in a very flou
condition. In addition to this, there are twenty-one dividing
dividing $30,000 worth per month, at a cost of 3½ per cent
profit of 20 per cent on purchases; a saving of $72,000 a
the families engaged in them. Quite a large amount of s
corporations is owned by operatives, and several hundred th
dollars stand to their credit in savings banks, besides a
amount in real estate."

The report for 1875 devotes fifty pages to the sub
distributive co-operation, and gives returns from nea
the distributive co-operative societies in the State.
information contained in the article is exhaustive, and

the most complete presentation ever given, in this State, of co-operative principles and their extension among the classes likely to be benefited by their introduction. The advantages of co-operation are thus explained :—

"Distributive co-operation will help that man and others who avail themselves of it. If one purchases a barrel of flour at a co-operative store for a dollar less than one of the same quality can be bought elsewhere, he has saved the earnings of a third or half a day's work. If, as experience appears to indicate, about ten per cent can be stated as an average return to the purchaser of money paid in, on a trade of $250 per annum, $25 is saved. This is not all, however: being a member with others, he knows that the articles he is receiving came in unbroken packages from the producer or wholesale dealer, and that they are free from adulteration by deleterious or other ingredients; hence they will go farther. He knows, too, that he obtains full weight; consequently his purchase will last him longer, so that he receives a substantial gain from three sources."

XI.—The Census and Industrial Statistics of 1875.

The first officers of the bureau, Messrs. Oliver and McNeill, saw at the outset of their work that the limited appropriation allowed the bureau, and its want of power, would prevent the investigations having that force that comes from numbers. An average based upon fifty returns may be as true as one founded on fifty thousand; but the argument to prove it can never be made as effective as the fifty thousand returns themselves. The officers above named, in the report for 1871, recommended—

"The authorization by law, with methods of carrying it into effect, of a thorough and exhaustive system of statistics, to be gathered by the parties employed in taking the next state census, in 1875, covering the subjects of the wages, earnings and savings, time employed and lost, of all classes of working people, the number of persons (men, women, young persons and children) employed in the several industrial occupations in the Commonwealth, and of other matters connected with the subject of labor in the State."

The same officers repeated the recommendation in the report for 1872, and reiterated it in that for 1873. In the latter report they also said :—

"We would recommend that
the agents or superintendents o
establishments, the treasurers (
facturing, mechanical, mercantil
etc., be required to report to thi
of September of each year, an
ownership of property, wages,
etc., pertaining to the question (
establishing the bureau."

A bill similar to the above
in the House in 1876, with t
recommendations of Govern
is recorded on page 301.

Messrs. Wright and Lon
tained the recommendations
30, 1874, the following Act

[Chap. 38

AN ACT to provide for taking the Ind
Com

SECT. 1. The industrial sta
year eighteen hundred and se
direction of the bureau of statis
of the several cities and towns

SECT. 2. The decennial ce
by articles twenty-one and tw
constitution, shall be taken by
gather the industrial statistics
and the returns thereof shall b
tary of the Commonwealth.

SECT. 3. The secretary of
of the board of agriculture, a
revise the schedule of heads o
hundred and forty-six of eight
gest to said bureau such alte
relating to the subjects withi
may respectively deem advis
shall revise the schedule, with
proposed, and lay the same,
council for their approval, on
next; and the said schedule,
council, shall take the place c

contained in said chapter one hundred and forty-six of eighteen hundred and sixty-five.

SECT. 4. So far as the returns of the industrial statistics from the several cities and towns relate to the amount, description and value of stock, and fuel consumed, and of articles manufactured; to the produce of land, quarries, kilns, coal-beds, ore-beds, and fisheries; to wool, wood, bark, charcoal, farm products, live stock, ice and products of like character; to vessels and boats built and buildings erected,—they shall embrace the year ending on the first day of May in the year eighteen hundred and seventy-five; and in all other particulars shall state the facts as they shall exist in the respective cities and towns on said first day of May, eighteen hundred and seventy-five, agreeably to such general directions as may be seasonably prescribed by the bureau of statistics of labor.

SECT. 5. The said bureau, after it shall have gathered the facts as called for by this act, shall cause to be prepared and printed true abstracts of the same for the use of the legislature.

SECT. 6. If any party authorized by said bureau to collect statistics under this act shall wilfully neglect to make true returns of his doings, as may be called for, he shall forfeit and pay a fine not exceeding two hundred dollars; and if any person shall refuse to give information required by this act, to a person duly authorized to receive the same, he shall forfeit and pay a fine not exceeding one hundred dollars.

SECT. 7. All fines arising under this act may be recovered in any court of competent jurisdiction, by information or complaint of the attorney-general, and shall accrue wholly to the Commonwealth.

SECT. 8. So much of section three of chapter sixty-nine of the acts of the year one thousand eight hundred and sixty-five as is inconsistent with the provisions of this act is hereby repealed.

SECT. 9. Chapter one hundred and forty-six of the acts of the year one thousand eight hundred and sixty-five is hereby amended so as to conform to the provisions of this act.

SECT. 10. This act shall take effect upon its passage.

Immediately upon the passage of the above Act, the bureau began its preliminary work. From the Industrial Statistics of the State for 1865, the United States Census of 1870, the censuses of New York and the British Empire, from documents supplied by Dr. Edward Jarvis, Gen. Francis A. Walker, and other statisticians, all possible information was obtained. Circulars were sent to the assessors of each town, requesting the names of new industries, and subdivisions of

old ones, started within
ten years. Every availal
industries or their subdivis
ers were requested to sub
information desired on the
was had with the board of
the insurance commission
section three. December
Schedule was presented i
council. December 22, tl
it was referred reported tl
and take great pleasure in
governor and council." '
day, and the schedule bec

A brief description onl
ule can be given here. It
of all forms and schedules
of 1874, forms a volume
MASSACHUSETTS." Copie
hibition at Philadelphia,
nent statisticians in this
its circulation may be d
synopsis of its contents :-

DIV. I.—*Manufactures.*—
mentioning by name, and de
ten hundred and seventy-six
tries. The general questio
the special inquiries numbe

DIV. II.—*Occupations.*—'
of eighty-six occupations.
forty-two special.

DIV. III.—*Products.*—Tv
one hundred and twenty-fiv
questions.

DIV. IV.—*Property.*—Tl
or description of fifty kinds

DIV. V.—*Special Inquiri*
ty-six special inquiries rela
twenty-four relating to *ind*
dren), eighteen submitted
tion, and three proposed by

The Indexes cover the divisions above mentioned, sixty-four subdivisions, and thirteen hundred and thirty-seven schedule heads upon which information was desired and provided for. The Appendix contains all laws pertaining to the subject, and copies of all schedules and forms used in the prosecution of the work.

Chap. 37, Resolves of 1875, provided compensation for taking the Census and Industrial Statistics, fixing the hours for enumerators at ten daily, and the pay at three dollars. One enumerator was allowed for each 1,500 polls.

Chap. 93, Acts of 1875, provided that the enumerators in the city of Boston should be appointed by the mayor and aldermen, and that a special enumeration of the legal voters residing in each street, avenue or square should be made. The privileges of this special enumeration of legal voters was also extended to the other cities of the Commonwealth.

The sum of $70,000 was appropriated on the 19th of April, 1874, to begin the work, and the work was commenced that day. Circular letters were sent to mayors and selectmen for the nominations of enumerators. Upon the receipt of names an explanatory letter as to duties, etc., and a commission, were sent to each; also a form of oath to perform duties as required by law. Upon receipt of the latter, schedules and instructions were forwarded, and on May 25th enumerators were engaged in the work, every town being provided for. Additional instructions were sent as necessity required, and a large correspondence was carried on daily to meet special points of inquiry. Each enumerator was required to keep a detailed time account, and make oath to the same. The names of parties refusing to answer inquiries were sent to the office upon "penalty notices." Correspondence was then entered into with the delinquent parties, and, in the whole State, less than a score of manufacturers have failed to comply with the requirements of the law. The enumerator made oath, also, as to the number of schedules collected, and gave, upon a form provided, his personal opinion of the accuracy of the work, showing, especially, points of failure, and items in his experience as a collector of facts. Census returns were soon received from the smaller towns, and the work of tabulation began immediately. Within a week after the arrival of the

last census returns a printed recapitulation of fourteen points upon the family schedule was presented to the secretary of state. The tabulation of the industrial statistics was commenced as soon as a suitable number of returns had been received.

In 1876, the sum of $46,000 was appropriated to meet the deficiency for 1875, and a further sum of $21,500 to complete the tabulations and preparation for the press. The whole cost, not including printing and binding, was $137,500. The number of men employed as enumerators was five hundred and twenty-nine. Average time of each man employed, fifty-one days. The whole number of properly filled schedules returned to the office was 506,702. The answers on the same are closely estimated at *thirteen millions.*

Schedule Forms and Manner of Tabulation.

The schedule forms used were six in number, and designated by the following names: Family, Individual, Manufactures, Occupation, Products and Property, and Special. A special instruction sheet was sent out with the Family schedule; the instructions were attached to the others. Every inquiry contained in the Industrial Statistics schedule found a place on one or the other of the specified forms. The following presentation will give an idea of the schedule arrangement as regards subjects:—

Family Schedule.—Name, Relation to Head of Family, Sex and Age, Color and Race, Conjugal Condition, Children, Place of Birth, Profession, Trade or Occupation, School Attendance, Private Libraries, Illiteracy, Diseased Conditions, Pauperism, Crime, Polls, Voters and Aliens, and the general points, Number of Families, and number of occupied and unoccupied dwelling houses.

Individual Schedule.—Occupation chiefly depended on for a living, whether at work, number dependent, hours employed daily, days employed yearly, daily wage, yearly earnings, other earnings, wife's earnings, minor children's earnings, chronic sickness and disability, number owning houses, mortgages, rate of interest on same, number of rooms hired, yearly rent, value of garden crops, cost of living, amount in savings bank and volumes in private library.

Manufactures Schedule.—General inquiries, Persons employed, Time employed, Wages, Work furnished Women at Home, "Team" work, Relief Funds and Libraries, Accidents, Motive Power, Size of

Establishment, Persons in each Story and Means of Escape in case of Fire, Gas Companies, Paper, Grist, Flouring and Lumber Mills, Tanneries, Cheese Factories, Machinery in Cotton, Woollen and Worsted Mills, Ship Yards, Book and Pamphlet Publishing, Newspapers and other Periodicals.

Occupation Schedule.—Occupations related to Manufactures, Persons employed, Time employed, Wages, Work furnished Women at Home, Relief Funds and Libraries, Motive Power, Accidents, Size of Establishment, Persons in each Story and Means of Escape in case of Fire, Cod and Mackerel Fishing, Wages, Profits and Investments of Persons employed in Cod and Mackerel Fishing, Shell-fishing, Whale Fishery, Fish taken for Oil or other Products, Fish taken for Food, Coastwise and Ocean Commerce.

Products and Property Schedule.—Domestic Manufactures, Hay, Agricultural Products, Number, Acreage and Value of Farms, Number, Description and Value of Buildings on Farms, Persons Employed in Agriculture, Wages in Agriculture, Value of Agricultural Implements in Use, Cultivated Land, Uncultivated Land, Fruit Trees and Grape Vines, Mines, Quarries, Pits, Domestic Animals.

Special Schedule.—Libraries, Public Schools, Incorporated and Unincorporated Private Schools, Reservoirs.

Of the half million schedules returned properly filled to the office, 359,000 were Family schedules, with twenty-one inquiries each ; Individual schedule, 80,893, with twenty inquiries ; Manufactures schedule, 10,730, with one hundred and five inquiries ; Occupation schedule, 11,641, with eighty-nine inquiries ; Products and Property schedule, 42,207, with forty-three inquiries ; Special schedule, 2,231, with twenty-one inquiries,—a total of two hundred and ninety-nine distinct inquiries.

The tabulations were conducted on newly devised plans, which demonstrated their efficiency by most satisfactory results. Each tabulation was subjected to the test of proof, and every omission or error brought to knowledge, corrected in detail.

The legislature of 1876 provided for the stereotyping of the census and industrial statistics abstracts, and for the printing, binding and distribution of six thousand copies of the same.

XII.

Beyond the point we ha is not history, and the out to indulge in prophecy c census and industrial st the bureau. The three Census, Schools and Libra tions; III. Agriculture. 1,500 pages in public doc

We do not think the ively summarized in a co it is needed. Whatever will be found the gratifyi lation, in the broadening in the results from the s not reaching its highest a faction. The officers ca and the hope of the prese a similar work is perform bureau work are convert sented will show an adva an advanced condition in ingmen and women, an in tion of their burdens, the of their toil,—all tendin solid glory of our honore

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